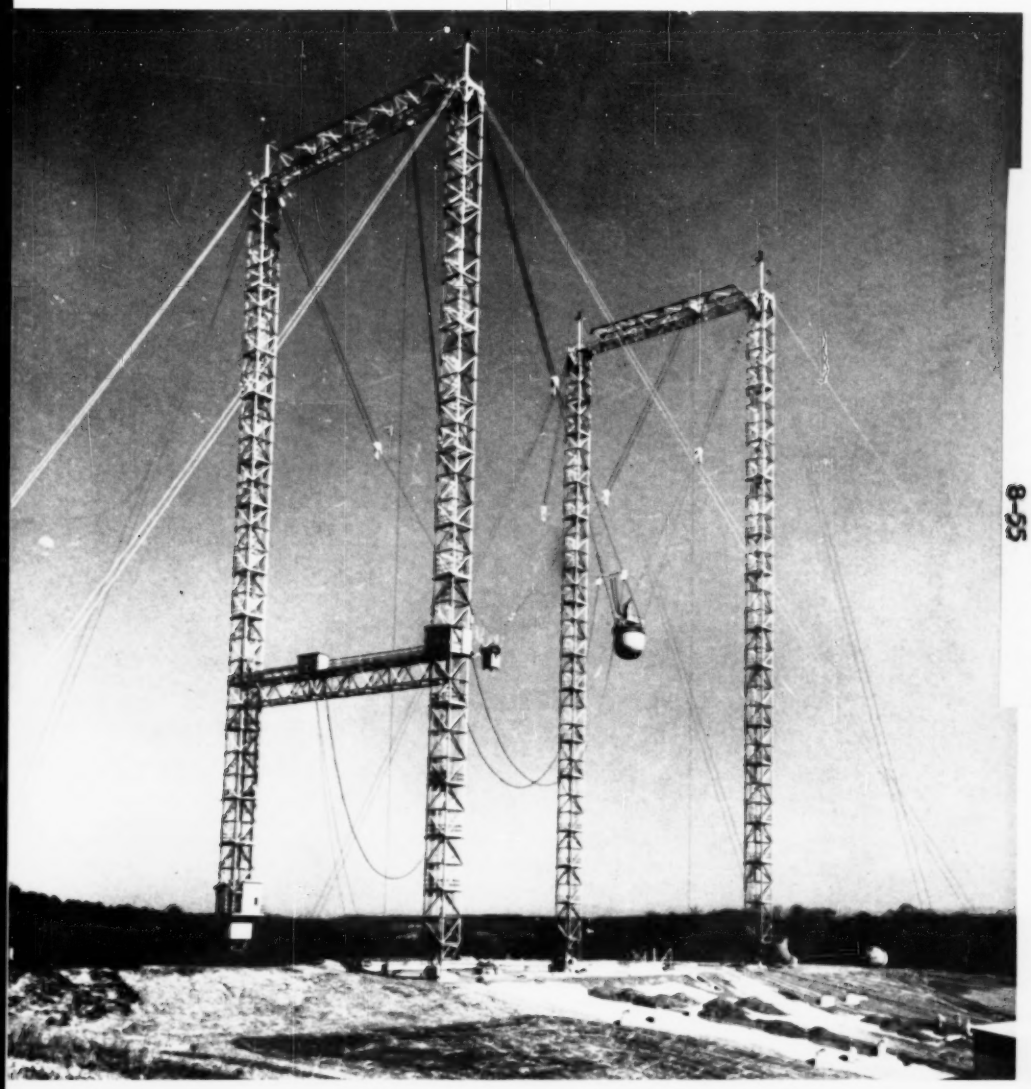
Compressed Air Magazine



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OCTOBER 1959

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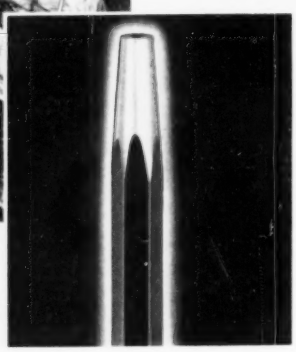
VACUJET

Drilling Team cuts roof bolting costs 3 WAYS!



1. VACUJET DUSTLESS STOPER CUTS OPERATING COSTS

Here's a stoper that includes its own built-in dust-removal system—gives you fast, clean drilling without any additional vacuum equipment. An ejector jet built into the drill backhead creates a vacuum that pulls all dust and cuttings down through the hollow drill steel and ejects them under positive pressure to any convenient dust collector. Even a simple canvas bag, as shown above, serves the purpose.

Because of its highly efficient ejection system, the Vacujet Stoper uses 15% less air and provides greater drilling power and speed. It's easier to set up and use, too. There are only two hose connections to the drill—the compressed air line and the dust discharge hose.

If you haven't tried the Vacujet, you don't know how simple and economical dry dustless drilling can be. Ask your I-R engineer for complete information, or send for Bulletin 4195.

2. CARBURIZED DRILL STEEL CUTS ROD COSTS

Ingersoll-Rand *carburized* drill steel is specially treated to provide exactly the right combination of hardness and core toughness to withstand millions of impacts without molecular fatigue. On job after job, these super-steels have outlasted ordinary alloy steel rods by two-to-one! This means less steel to handle—less time out for rod replacement. Rods are easy to recondition, too—simply cut off shank or grind Class B taper for bit end.

3. NEW "one-use" CARSET BITS CUT BIT COSTS

Here's a long-life, heavy-duty tungsten carbide insert bit that can be drilled to destruction *without any resharpening*. One Carset bit will outlast 16 to 20 "one-use" steel bits—at a saving of up to $1.60 per bit cost alone. More important, the time saved changing steel bits is converted into drilling time. On typical applications, "one-use" Carset bits are drilling 235 ft. where steel bits lasted $12\frac{1}{2}$ ft.—and 350 ft. where steel bits were completely used up in 17 feet of drilling. Available in $1\frac{1}{2}$" and $1\frac{3}{8}$" sizes, with Class B taper connection. No shims needed.

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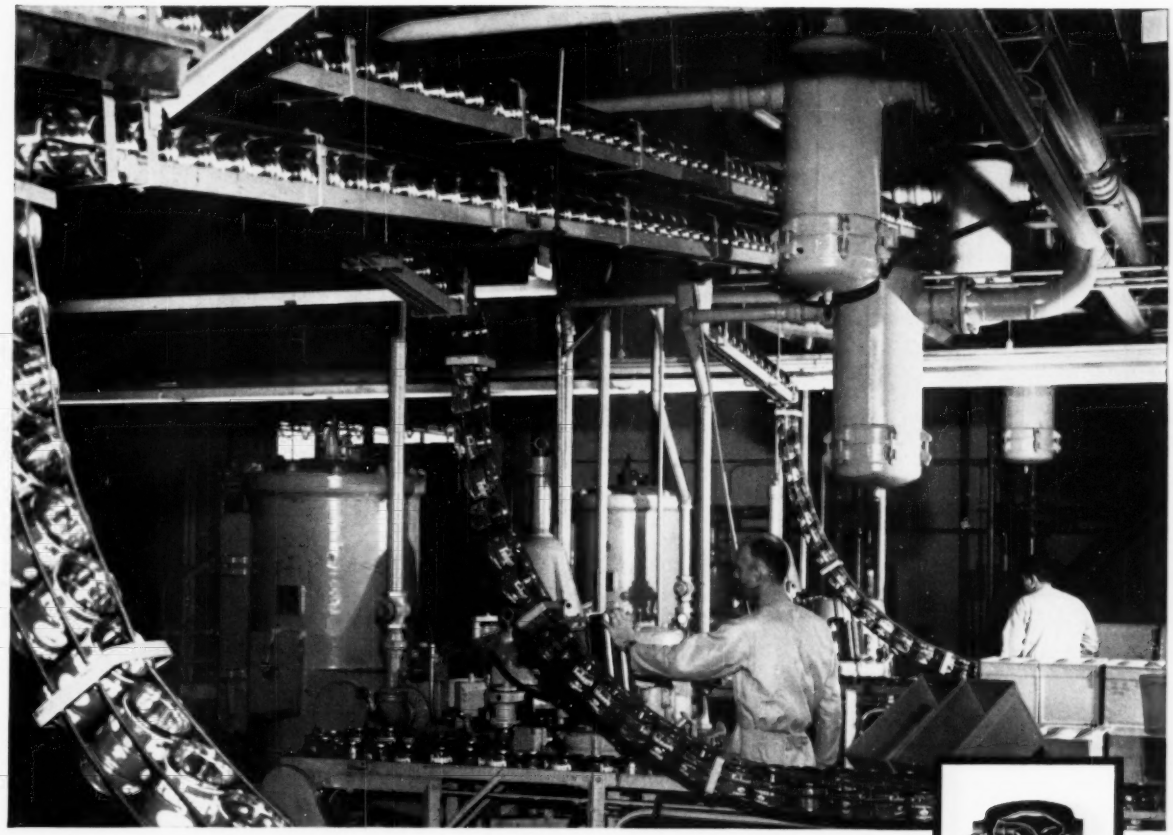
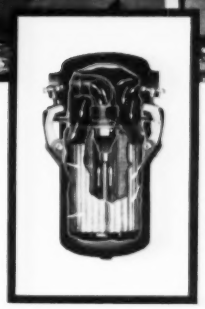


STAYNEW FILTERS KEEP TROUBLE FROM BREWING AT FOLGER'S COFFEE PLANT



Model CVH Staynew Filter used at Folger's. Filter inserts consist of Feltex 12 wool felt, are cleaned only once weekly.

At Folger's multi-million dollar plant in Los Angeles, Staynew Pipeline Filters play a vital role in vacuum packing—in fact, they literally keep trouble from brewing.

In vacuum packing shutdowns for pump repair cannot be tolerated. Pumps "suck" air from coffee cans before they are sealed for shipment. When this air is drawn off, some coffee particles are bound to come with it. At Folger's, Staynew Filters protect the vacuum pumps by preventing these particles from getting to them. Located between the production line and the pumps, Staynew Filters first mechanically clean the incoming air by forcing heavier particles into the base of the housing. Then, flowing through the Radial Fin Filtering Insert, any remaining airborne materials are removed, leaving only clean air to pass to the pump. Mechanical separation before filtering reduces the load on the filtering element. Low velocity with unusually low resistance to flow results. This keeps line pressures at the proper operating level and offers a tremendous saving in horsepower.

Designed to eliminate frequent cleaning, Staynew Filters contain a liberal space in the bottom housing for large particle accumulation — this can be drained off without shutdown. The Radial Fin construction of the filtering element provides an extremely big active filtering area—this means a greater amount of filtering over a longer period of time. For inspection and cleaning, large swing bolts permit removal of the lower housing, offering easy access to the filter interior without breaking pipe connections.

Assuring sustained, trouble-free operation of pumps at high load factors, Staynew Pipeline Filters have been successful in the packing of millions of pounds of coffee annually at Folger's. They've also gained wide acceptance in the processing of canned meat and other foods, and on vacuum degassing and high vacuum metal processing systems, to name a few. There's a Staynew Filter for every job—find out how you can save time and money on your particular application—consult a Dollinger representative, or write for Bulletin 200. Dollinger Corporation, 7 Centre Park, Rochester 3, N. Y.

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Compressed Air Magazine

Founded 1896

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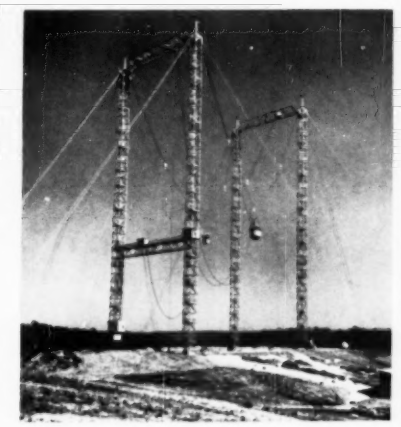

Photo, U. S. Atomic Energy Commission

ON THE COVER

SHOWN is the Atomic Energy Commission's tower shielding facility at Oak Ridge, Tenn. Suspended between its four 323-foot-high towers is an experimental swimming-pool-type reactor which is operated remotely from an underground control room. The big towers each rest on a small glass ball and are guyed by 2.5-inch-diameter galvanized cables. The reactor hangs from four 1-inch cables, each leading to an independent dynamically braked hoist. The research tool simulates flight conditions for studies into aircraft reactors and their shielding.

FEATURE ARTICLES

Page 10. **High-Quality Book Papers**—*R. J. Nemmers*

Vacuum uses on a Fourdrinier paper machine are many and varied. Detailed is the P. H. Glatfelter installation of a 188-inch, high-speed machine for producing quality papers. The unit scores a number of "firsts" in the industry, including the type of vacuum pump used.

15 **Quarry Compressors: From Stationary to "Portable"** —*G. R. Smith*

Two electric-driven stationary compressors, mounted on specially enclosed trailers, provide a portable air supply system for blast-hole drilling at The Carbon Limestone Company. The units and the overall operation at the quarry are described.

18 **The Realm of Research**—*S. M. Parkhill*

The many facets of research necessary for continued economic growth are increasing in complexity. Rand Development Corporation reflects this trend in its own development projects as well as in those undertaken for client-companies.

22 **Whales and Rockets**—*Peter Sleight*

The rising cost of whale oil as an illuminant drove men to look for a less expensive substitute. When the first commercial American oil well was brought in, kerosine became available in quantity. This petroleum product flourished, then became nearly extinct. It is again coming into demand.

26 **Water for a Thirsty People**

A sea water distillation plant, recently established on the resort island of Aruba, was quickly completed because required insulation was placed pneumatically.

30 **For Speeds to Mach 27**

Boeing Airplane Company's "hotshot" wind tunnel uses a highly charged arc of electricity to trigger tests in which high-pressure air at 2000 psig rushes through a tiny tungsten throat.

33 **New Air Line Filter**

The device described removes moisture, oil and other entrainments by separation rather than by customary absorption processes.

DEPARTMENTS

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Bethlehem Wire Rope Helps Clear Way for Mountain Highway. This action photograph shows Bethlehem 1⅛-in. shovel hoist ropes at work on a 2½-mile road relocation project atop Broad Mountain, on Pennsylvania's winding Route 29. The contract, supervised by the Pennsylvania Dept. of Highways, called for the removal of 900,000 cu yd of sandstone and earth.

On this job the Bethlehem wire rope is subjected to hard usage, day after day. Yet it keeps coming back for more—just as it is doing in thousands of construction jobs all across the land.

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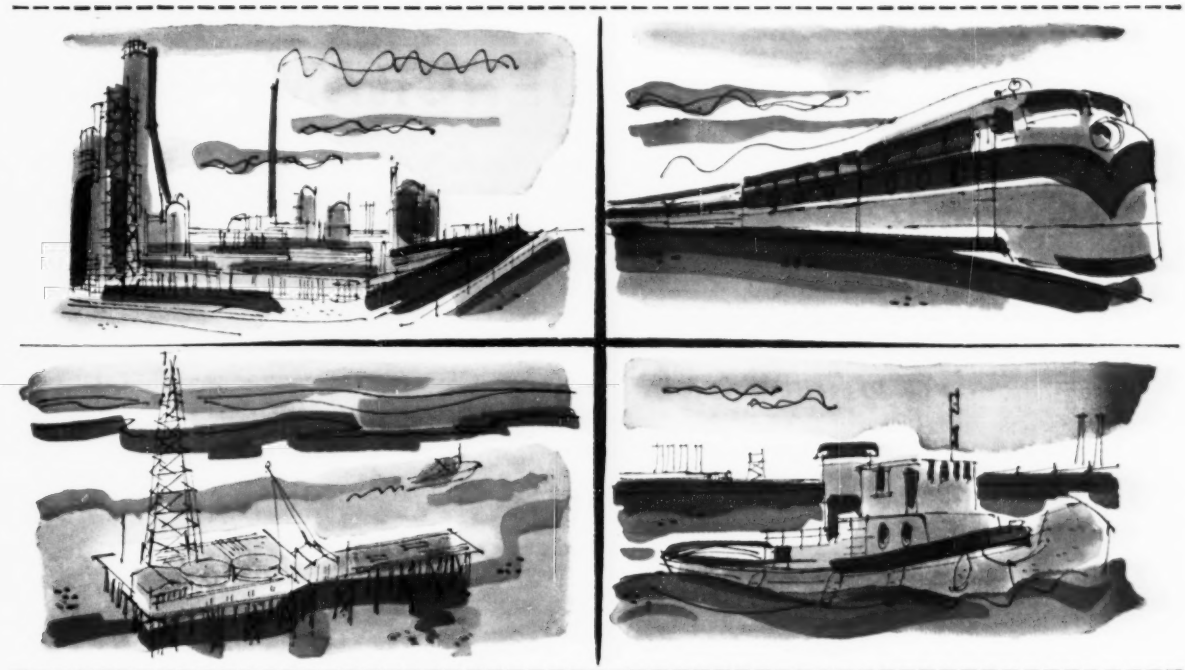

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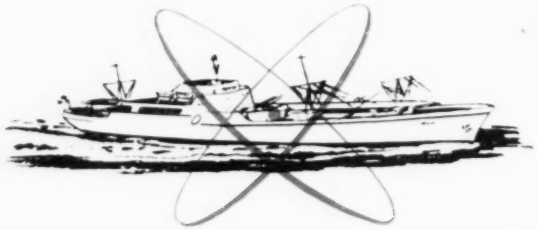

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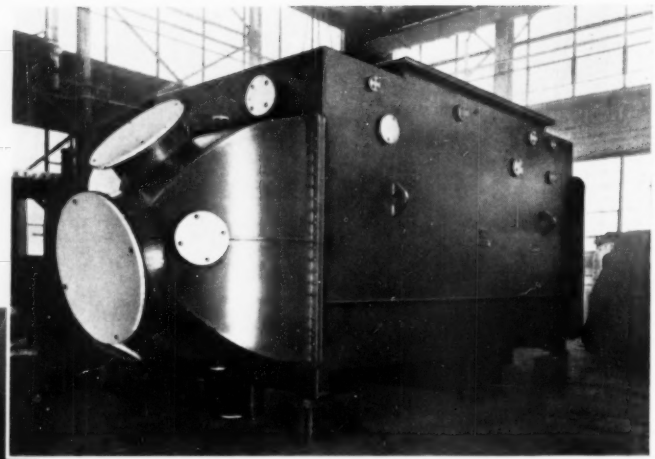

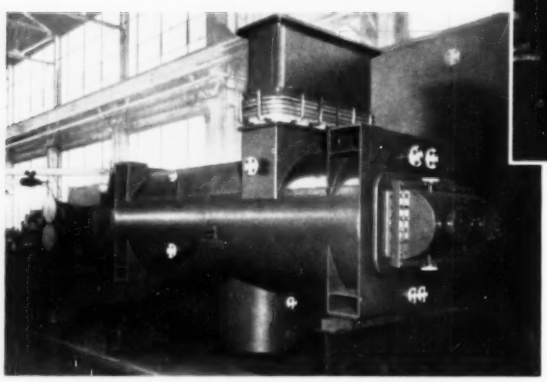

MAIN CONDENSER for N. S. Savannah has 22,360 sq. ft. of effective condensing surface, made up of 5,696 ¾" tubes 20' long — will condense 138,900 lb. of steam per hour.

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IN DESIGNING the condensing equipment for the nuclear-powered N. S. Savannah, I-R engineers applied a combination of advanced techniques and designs not generally used in conventional I-R condensers. Special attention was given to protection against contamination of the condensate. At the same time, all of the proven high-performance principles of heat transfer which I-R pioneered have been made an integral part of the N. S. Savannah condensers. Here are some of the outstanding features:

- Tubes are welded to the tube sheets at both ends to prevent leakage of sea water into the condensate. After welding, each tube is rolled and expanded into the tube sheet for mechanical support.
- Further protection against condensate contamination is provided by a unique arrangement that eliminates the necessity of cumbersome double tube-sheet construction.
- Main condenser is designed to receive by-pass or "dump" steam from the steam generator.
- Effective control of steam flow and velocities through the entire condenser eliminates air blanketing, thus providing more efficient heat transfer.
- Reheating and deaerating hotwell design maintains lowest possible oxygen content and minimum condensate depression.

In addition to the surface condensers, Ingersoll-Rand is also supplying the steam-jet ejectors, in-port boiler-feed pumps and non-lubricated compressor for combustion-control air on the N. S. Savannah.

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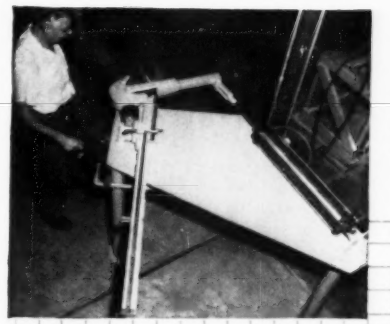
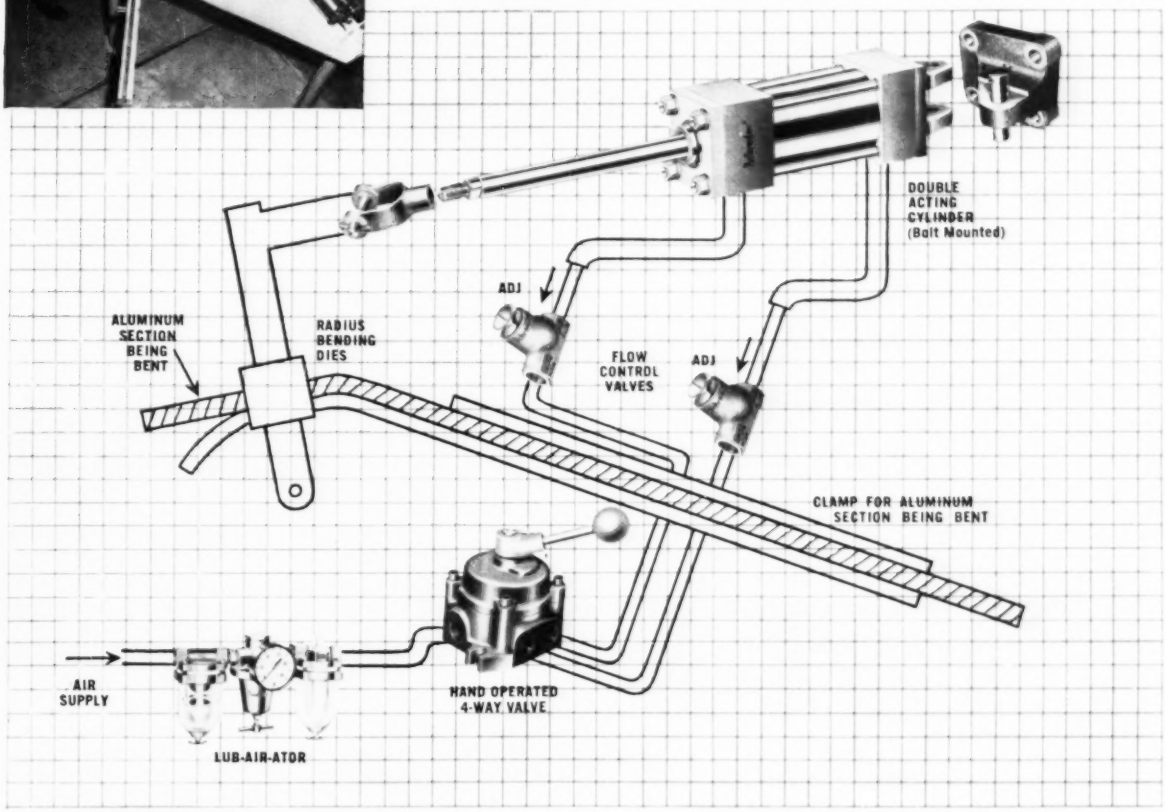


A typical example of how fabricators use Schrader. Schrader Air Products in the schematic perform a metal-forming operation at Lance Awning Corporation, Lake Worth, Florida. Power is supplied by a Schrader double-acting bolt-mounted air cylinder. By pressing the Schrader 4-way valve, the cylinder piston advances at proper speed, checked by Schrader flow control valves, bending an aluminum section to the desired angle. Reversal of the 4-way valve returns the cylinder and bending dies to rest, permitting removal of the bend section. "Air control provides a straightforward one-man job," says the Plant Manager. "Two men worked hard to form this radius bend on 25 parts per hour before a Schrader Air Cylinder was installed. Now one man forms 35."



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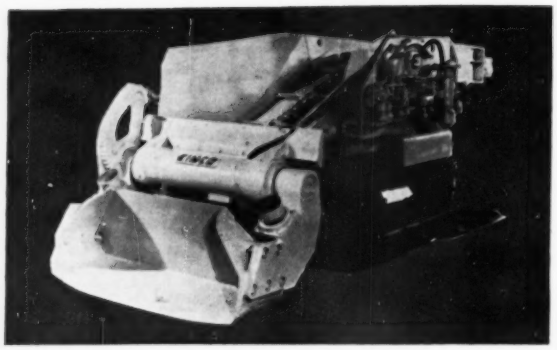
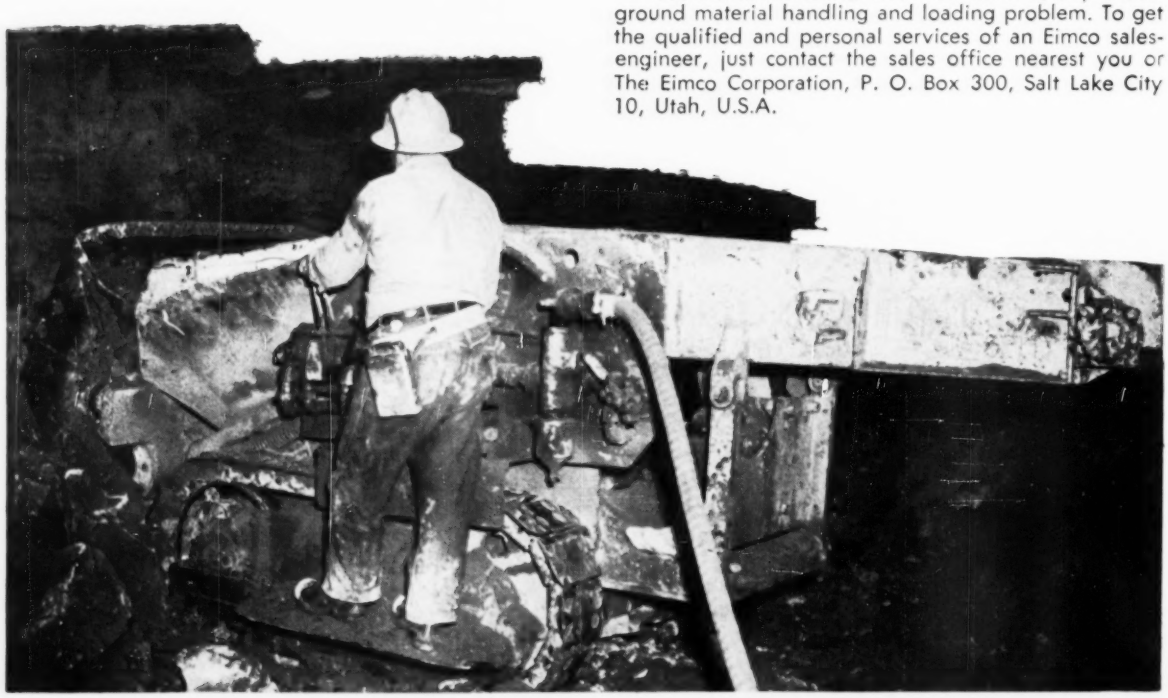


That's the enthusiastic word from T. W. Newell, Vice-President and manager for Shattuck Denn Company. Operating a five foot low-headroom machine at their Bardon Shaft near Moab, Utah, this progressive mining company is presently driving seven headings. Their efficient Eimco 635 Low Headroom Conveyor Loader handles four per shift, loading into shuttle buggies. Complete time cycle of loading each three to four ton buggy is consistently under two minutes and usually closer to 100 seconds; is capable of handling 100 tons per hour.

Frank Garrett is mine superintendent at this operation, which also uses an Eimco Air Tugger Hoist to pull the drill jumbo to one side when it is hoisted out of the shaft and an Eimco 42" Folding Scraper to load their skip pocket.

You'll find that Eimco has the answer to any underground material handling and loading problem. To get the qualified and personal services of an Eimco sales-engineer, just contact the sales office nearest you or The Eimco Corporation, P. O. Box 300, Salt Lake City 10, Utah, U.S.A.



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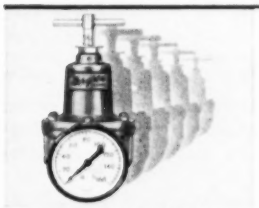

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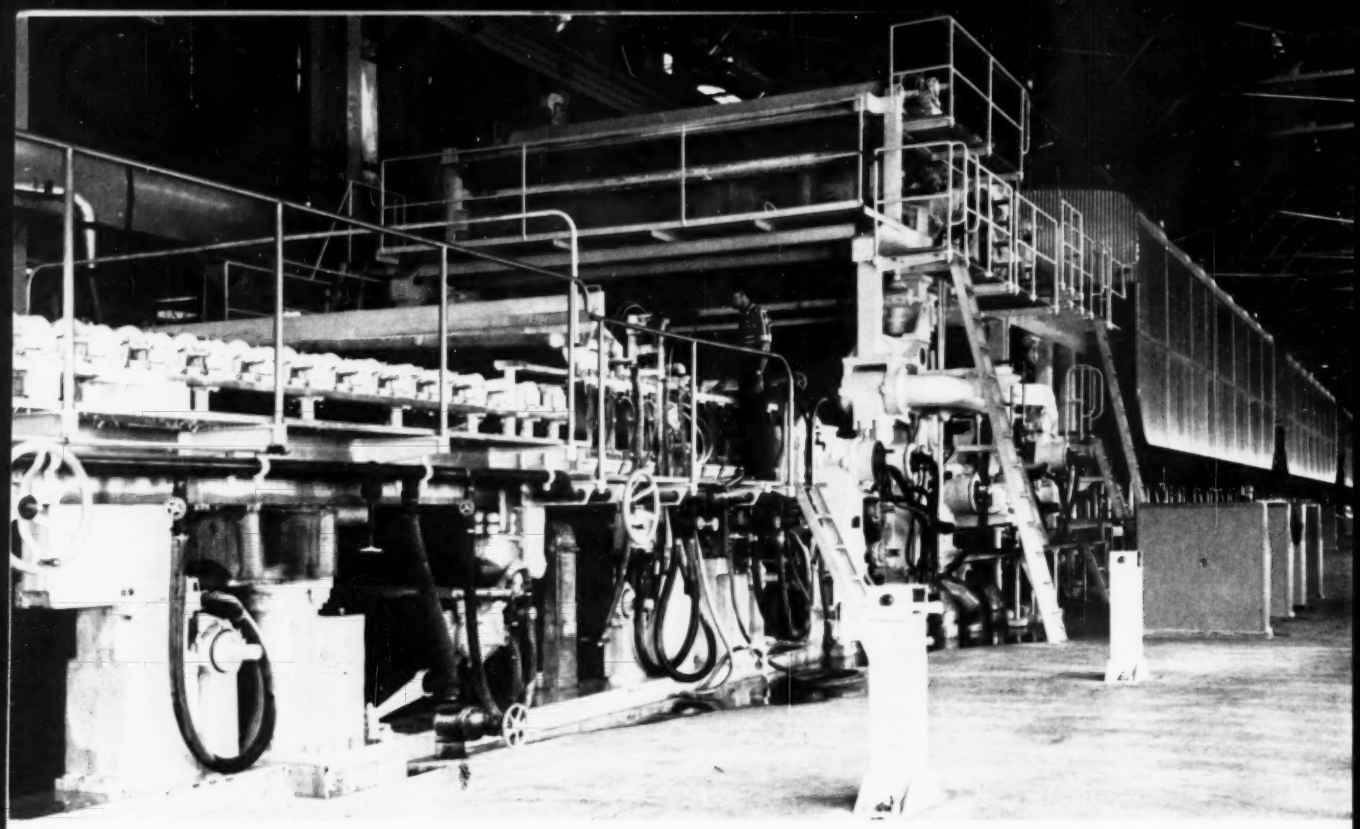


GLATFELTER HAS LARGEST, FASTEST FOURDRINIER FOR—

HIGH-GRADE BOOK PAPERS

R. J. NEMMERS

CARRIED out long enough, almost every discussion of the present state of papermaking gets around to the question of whether it's a science that relies on craftsmanship for highest quality; or an art that is dependent on science for a superior product. There is so much to be said for either that about the only conclusion is that there is a great deal of both art and science in the manufacture of high-quality paper.

In the realm of science the P. H. Glatfelter Company about 2 years ago completed at its Spring Grove, Pa., facilities, a multimillion dollar expansion program that includes one of the world's most modern and fastest book paper machines designed to turn out high-quality papers. The $12,500,000 expended paid for: the new machine; a 600-foot-long building to house it and its accessory and supporting machines; a 137-acre lake, assuring adequate water supplies; and a 250,000-pound-per-hour steam boiler, developing 600 psig at 650° F total temperature.

In the realm of art, the 94-year-old Glatfelter firm is still managed by members of the family that founded it. The mill, in 1864, turned out less than a ton of crude paper each day. Just before the last major expansion program, some 225 tons of paper per day could be produced. The new machine has an ultimate capacity of 300 tons per day and is now operating at approximately half that figure.

The several generations of owner-management can be matched by the working force, many of whose members had fathers and grandfathers precede them in their jobs. The high employee morale and low turnover are said to result from the attitude both of management and the employee that papermaking is truly an art. The mill provides work for 900 individuals and, almost unique in industry today, there has never been a strike at the plant.

The customer relationship enjoyed by Glatfelter is also a point of pride. Many buyers have patronized the company for more than 30 years; their consumption even today accounts for a large portion of output. The plant has operated for many years at full capacity, three shifts per day, 6 and even 7 days a week. Its increased capacity, however, now makes it possible for the firm to aggressively seek new customers.

About Quality

The most inexperienced layman recognizes that paper isn't just paper. Each day we are confronted with an almost bewildering variety of types and grades. Papers are selected for a specific task. Such requirements as ink receptivity, the printing surface, workability, reaction to chemicals, permanence, the vagaries of different printing processes and physical properties must all be considered. The physical properties of paper are color and brightness, strength, finish, formation, sizing, bulk, opacity, cleanliness and moisture content. All have bearing on the ultimate use of the paper.

All papers may be said to be made in essentially the same way, a technique familiar to every school boy. It is only in the control exercised over the operation, from the tree in the forest to the counting and sorting of the finished

VACUUM USES

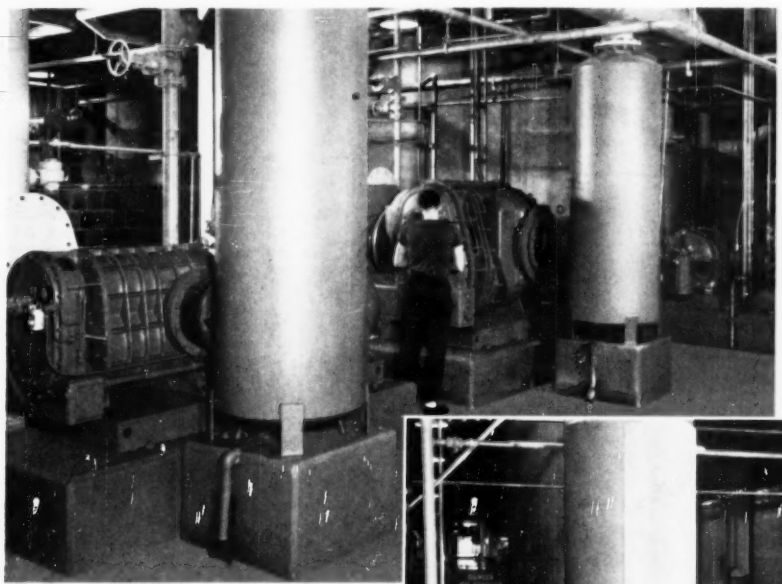
This illustration, showing (left) part of the Fourdrinier and (center) the press section, points out most of the major vacuum uses of the Rice Barton 2000-foot-per-minute paper machine. The flat boxes are seen alongside the papermaker's legs. One step along the machine to the right is the mounting for the couch roll. Next in line is the suction pickup, then come the transfer press, first press and second or inverse press. Two of the three felt conditioners lie above the line of the paper web and one is below it. The suction wringer roll mounting can be seen at the top of the first ladder leading to the press section's overhead walkway. The hooded portion of the paper machine at the far right houses the dryers; the small consoles at floor level, control equipment.

sheets, that papers differ to any degree. Included in the "catchall" of control are such things as the variety of pulp used, the degree and manner of working, cooking and bleaching, the amount of nonfibrous materials added (clay, fillers, glues, sizing, dyes, etc.), the amount of water and the settings of the paper machine and dryer sections as well as finish calendars. Indeed, there are so many individual conditions that must be controlled in the manufacture of paper that to the casual observer it often seems that there are many more things that can go wrong than human skill can possibly put right. Yet upon the pin point control of all of these factors, and upon its employees' ability to reproduce any given set of conditions, rests the reputation of Glatfelter.

Facilities

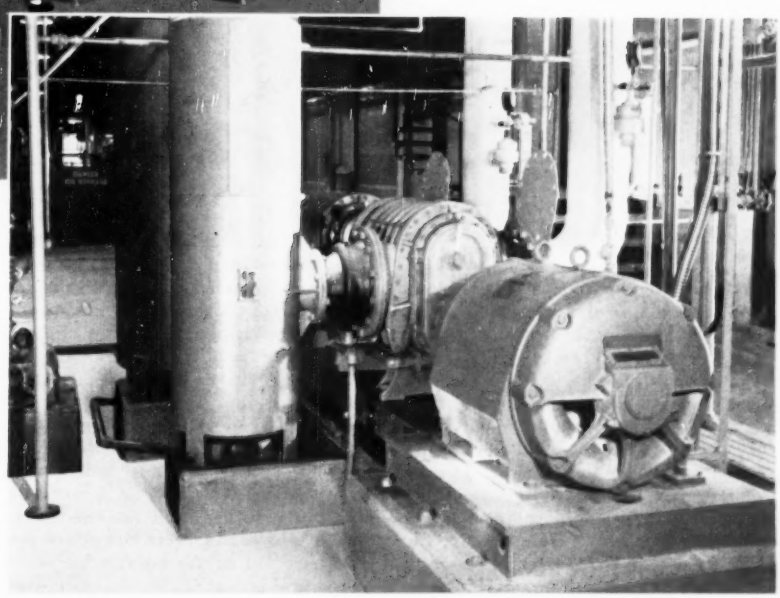
In addition to the new machine which has a 188-inch-wide Fourdrinier wire, paper is made on six other machines ranging in web widths from 55 to 190 inches. Steam for the mill is furnished by a 4-boiler plant having a total capacity of more than 500,000 pounds of steam per hour. Two of the units, including the new 250,000-pound-per-hour Combustion Engineering plant, deliver steam at 600 psig and are the base load carriers; the other two generate 350-psig pressure and are on stand-by. Three turbine-generator sets are installed having a total capacity of 16,250 kva. In addition, a Metropolitan Edison substation can feed up to 7500 kva into the plant to supplement company-generated power. An 1850-hp Westinghouse M-25 variable speed steam turbine powers the 188-inch machine.

Stock preparation is handled by continuous primary refiners and Jordans. Four basic stocks are utilized: long fiber, short fiber, deinked and "broke," the latter being repulped paper resulting from mill trimmings, etc. Virgin pulps are supplied by a pulp mill on the site (utilizing a chlorine dioxide bleach plant) with the difference in capacity between the Glatfelter installation and the paper machines being made up with purchased pulps. The Glatfelter mill utilizes centralized control panels throughout the stock preparation and proportioning systems. Many of the operations are automatic and/or fully instrumented in the interest of closer control over the many variables.



Axi-compressors

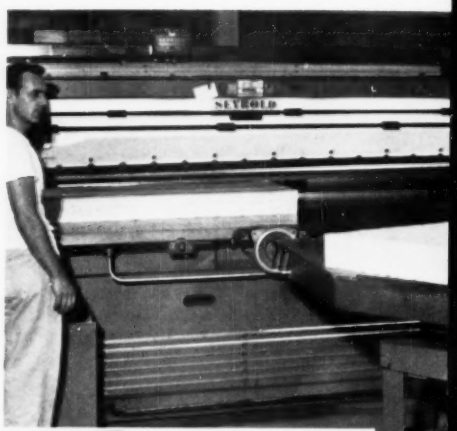
Three of the seven Axi-compressors serving the 2000-fpm Rice Barton paper machine are shown (left). At the left is a 105×25 unit powered by a 1770-rpm 100-hp motor pulling a vacuum on the suction wringer roll. The center machine is a 175×30 Axi-compressor driven by an 870-rpm 250-hp motor that is utilized in connection with the couch roll. At the far right is a 1770-rpm 105×25 unit serving the pickup roll.



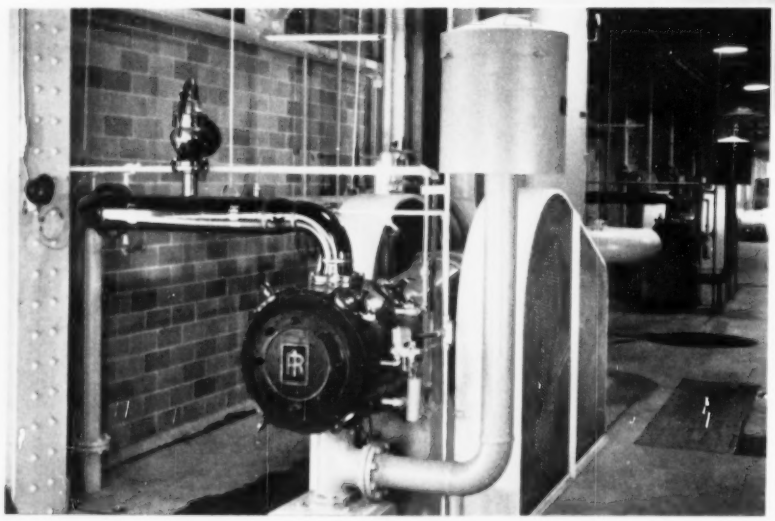
In the picture at the right is shown a tandem hookup of two 121×20 machines serving the first and second, or inverse, presses. The twin units are driven by a single 1770-rpm 300-hp motor, both compressors and the motor being direct-coupled in line.

Compressed Air In The Papermill

A variety of compressed air applications are to be seen in the Glatfelter mill. Many of the rolls and rotating joints on the dryer and finishing machines are air loaded. A "saveall" that recovers fibers and reclaims process water for further use depends on the flotation effect derived by dissolving air under pressure in the so-called "white water" effluent. Slitters and rewinders are equipped with air clutches and brakes. Many of the instruments by which Glatfelter papermakers maintain close control of quality are of the pneumatic type.



Shown below are two Ingersoll-Rand Class ES 100-psig single-stage air compressors that supply general service air to the paper mill. Each is driven by a 75-hp Westinghouse motor through a V-belt drive and discharges to an I-R PL-12 pipeline aftercooler.



Because down time on the big machine is expensive, these five air hoists are installed to make quick work of changing the Fourdrinier wire. Ingersoll-Rand Model D60 utility hoists, the units are arranged, by means of the simple yoke shown, to handle a pair of cables each.

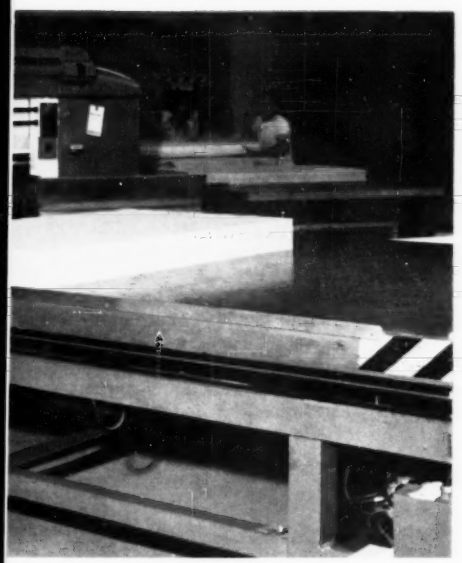
The Big Mill

The 188-inch Rice Barton machine is said to be one of the first of such speed to be utilized in the making of high-quality papers. (There are, of course, a number of units of as great and even greater speed being used in the manufacture of newsprint and similar grades of paper.) The machine utilizes a suction pickup roll to transfer the paper web from the Fourdrinier wire to the press felts, a development also new to book-papermaking. Designed for variable speeds from 333 feet per minute (wire speed) to 2000 fpm, the unit operates at a maximum of about 1500 fpm at the present time.

To accommodate the high-speed characteristics of the machine, a unique head box (more properly, a flow spreader) is installed to feed the stock onto the wire. It is said to be the first of its kind in the United States. It utilizes a multiple-nozzle tapered header to regulate the stock flowing onto the wire. The pressure in the flow header is determined by the speed (output) of a variable-flow fan pump rather than the head in the usual box or reservoir suspended over the feed end of the Fourdrinier screen. The fan pump is an Ingersoll-Rand Model 20 LFV unit having a total head of 33 feet and a maximum capacity of 15,000 gpm. The critical variable-speed drive for the LFV pump is made up of a 150-hp Allis-Chalmers motor driving the input end of an Electric Machinery magnetic variable-speed controller at 1770 rpm. The output end of the EM unit drives the pump through a Philadelphia gear reducer at a speed determined by the screen speed on the Fourdrinier, and such other variables as may be introduced by the grade and variety of paper being made.

Vacuum Plant

In addition to the large size and the departure from accepted head box design, the 188-inch machine scores another first with its vacuum system. Utilizing a total of seven of a variety of vacuum pump relatively new to the paper industry, the Glatfelter mill represents the first such complete installation in its industry.



This giant 100-inch Seybold guillotine trimmer is one of the largest of its type ever installed. It is used for trimming sheet stock to final dimension. The heavy lifts of paper are delivered to the trimmer by the mechanically advanced table at the right. Both the feed table and the press table make use of the air-film principle to make light work of positioning the heavy piles of paper.

A number of advantages are claimed for these pumps, among them, compact construction, low weight and low seal-water requirements. For example, a unit having a capacity of 5000 cfm weighs less than 5000 pounds and thus takes less foundation mass and is more economical to put in place than a heavier type. Further, the units can be sealed for operation to 20 inches of mercury (Hg) vacuum with 1 gallon of water per 1000-cfm capacity, as compared with other units requiring up to 50 gallons of seal water for a like rating. (For vacuums to 12 inches Hg, no seal water is required.) The high-speed machines can be direct coupled to standard drivers eliminating the need for more costly low-speed drivers, transmissions or V-belts.

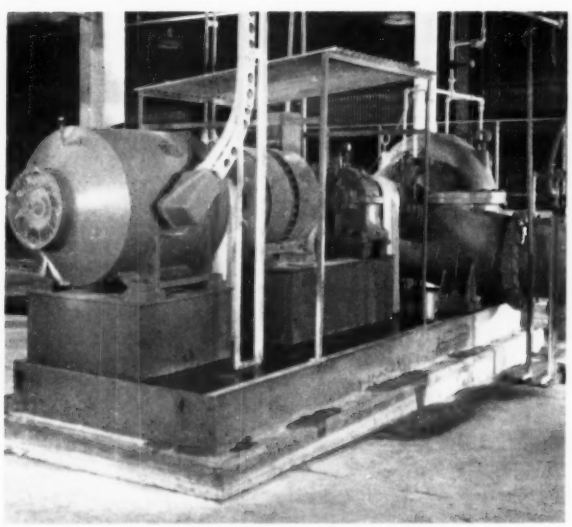
The original vacuum installation was purchased from Read Standard, Inc., on the basis of its compactness and low seal-water requirements. (Soon after the units were installed, rights to the so-called Standardaire line of rotary compressors and vacuum pumps were purchased by Ingersoll-Rand Company. Renamed the Axi-compressor line, it is now manufactured and sold by the 78-year-old specialist in air and vacuum equipment.) With the start-up of the paper mill certain difficulties in the operation of the vacuum system became apparent. Engineers from Glatfelter, Read Standard and Ingersoll-Rand worked closely in overcoming the initial problems of the untried vacuum plant design.

The separators for a wet Axi-compressor system can be designed in two ways. If sufficient height is available, a barometric drop leg may be installed at the bottom of the separator tank to carry away water without breaking the vacuum in the system. If only limited headroom is available, a water removal pump may be substitued for the barometric leg, the design of the system at Glatfelter. With certain modifications of the original design, the machines fulfilled expectations as to savings in seal water and have performed as expected on each of the important vacuum applications.

Vacuum Uses

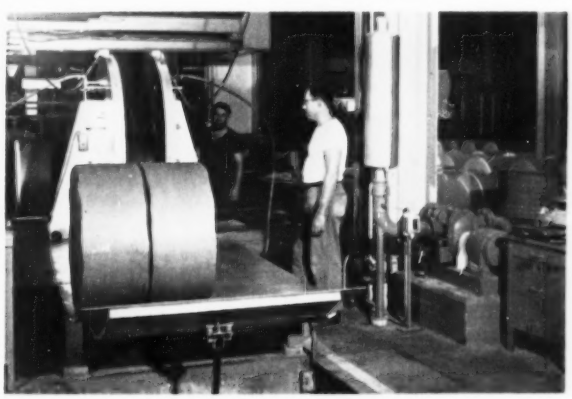
There are eight general and specific locations on the 188-inch Glatfelter machine requiring vacuum. In the order that they meet with the paper web as it is being made, they are the flat boxes, the couch roll, the pickup roll, the transfer press, the first press, the second or inverse press, plus the felt conditioners, and a suction wringer.

The flat boxes—eight of them—underlie the Fourdrinier wire at its discharge end. Water from the web is drawn into the boxes as it passes over them. Each box is 8.75 inches wide inside with a suction area 7 inches wide by the width of the wire and is mounted on vertical leaf springs to permit oscillation, a rocking motion being imparted by hydraulic cylinders.



FLOW SPREADER FEED

This Ingersoll-Rand 20 AFV fan pump feeds the flow spreader that replaces the customary head box on the 188-inch Rice Barton paper machine at Glatfelter. The unit is driven through an Electric Machinery variable speed magnetic coupling and a Philadelphia Gear Works reduction case by an Allis-Chalmers 150-hp motor. Speed (output) of the pump determines flow rates from the flow spreader. The discharge line feeds a bank of eight venturi throats that lead to the flow spreader.



AIR-VACUUM TEAMWORK

Shown in this illustration is a roll heading machine on which air and vacuum team to provide time and labor savings. This machine receives paper rolls from the trimming floor above and wraps them for shipment. The platens shown at the left glue side covers on the circumferentially wrapped rolls. These covers are automatically glued by a spray gun and set into position against the platens where vacuum holds them in place. Then the roll is brought into position and the heated platens move in, powered by air cylinders, and press the glued covers to the roll sides. In a matter of seconds the glue is set and the roll is released onto an automatic scale from which it rolls onto the lowering deck shown in the foreground. At the right is a 450×6 Axi-compressor which is used "dry" (without sealing water) to draw the vacuum on the platens. The unit is powered by a 3550-rpm 5-hp motor.

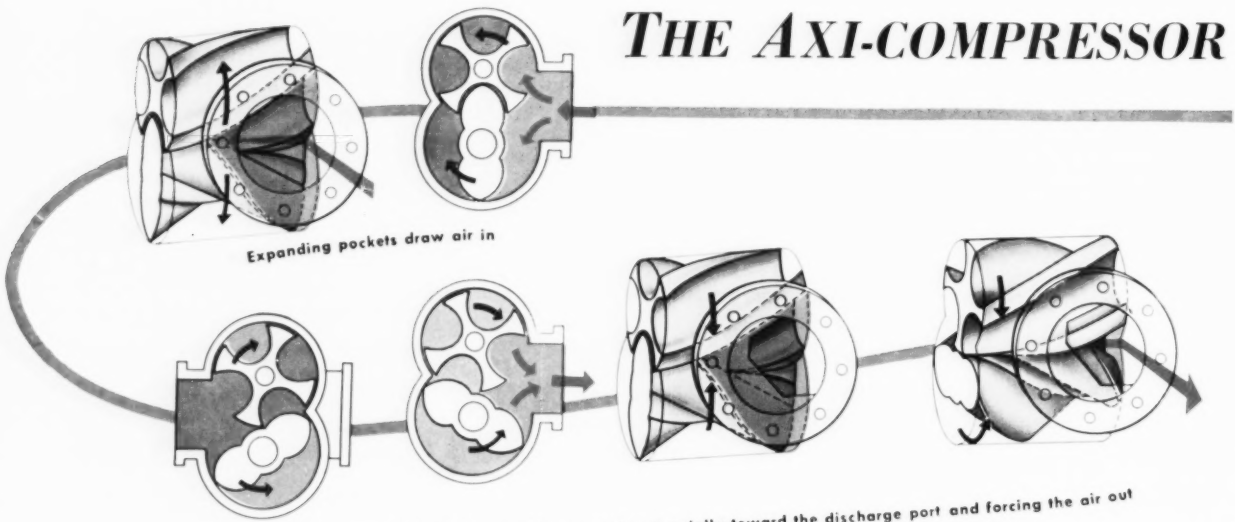
The couch is a 36-inch-diameter roll with myriad rows of holes drilled on a face of 190 inches. Inside is a 10-inch-wide suction box that draws additional water from the web through the drilled holes just as the paper leaves the Fourdrinier wire. Above the couch is the suction pickup roll that picks the web of paper from the couch and guides it to the press section. When the paper sheet is picked up, it comes in contact on its topside with a felt. Within the suction pickup is a 2.5-inch-wide suction box running the length of the roll.

From the pickup, the paper sheet passes to the transfer press which squeezes and sucks more water from the sheet and also transfers it to another felt, this one contacting the bottom side of the web. The bottom roll of the transfer press is a 32-inch-diameter cylinder, drilled as are the couch and pickup, and containing a 5-inch wide suction box.

Following the transfer is the press section proper in which the final quantities of water are extracted from the paper web to make it self-supporting. The web, as it enters the first press, is supported on the bottom by a felt (the same felt is common to the transfer press). Again the bottom roll is the suction roll and is the same size as the transfer roll. The paper sheet then moves to the second press coming in contact with another felt, this one contacting the web on the top. The second press roll is the top one and for this reason it is sometimes known as the inverse press. The roll is also of 32-inch diameter but has an 8-inch-wide suction box within. From this point the paper sheet is self-supporting and passes through the dryer section where its moisture content is further reduced as required by contact with heated rolls.

As the felts in the press section come in contact with the paper they pick up considerable quantities not only of water but of fibers. The felts are thus passed through so-called felt conditioners which are essentially vacuum cleaners. In addition, the felt on the suction pickup passes through a suction wringer which squeezes out water and draws it into a 24-inch-diameter suction roll.

THE AXI-COMPRESSOR


Expanding pockets draw air in
Pockets carry air to discharge side squeezing it axially toward the discharge port and forcing the air out

THE Axi-compressor is a comparatively simple machine. Only two moving parts are involved and there is no contact either between the two moving rotors or the rotors and the casing of the unit. Essentially the machine consists of a helical 4-grooved gate rotor (on the upper shaft) and a mating, 2-lobed main rotor on the lower shaft. The main rotor is driven externally and transmits motion to the gate rotor by means of 2:1 timing gear. In other words, the main rotor goes around twice for each revolution of the gate rotor. The intake and discharge ports oppose each other on either side of the machine but are located at opposite ends. The helical rotors move away from each other as they pass the intake port thus drawing in air. As they clear the portway, the lobes and gates entrap a given volume of air and carry it around to the discharge side. There, the rotors move toward each other and as the mating surfaces come closer together, the air is displaced, compressed and ejected from the discharge port.

The units require but a small amount of sealing water because of the minute clearances between mating parts. Because it is designed for high speeds, the unit is more compact than other varieties of wet vacuum pumps and this is applicable in limited headroom locations and for limited floor space requirements. Further, the units, it is claimed, can be staged for high operating efficiencies and can be direct connected to standard motors thus eliminating the need for V-belts, geared transmissions or special low-speed motors.

All units can be used over a wide range of conditions making them readily adaptable to changes in processes. For this reason, however, it is not practicable to identify the machines with the same nomenclature as reciprocating compressors because the speed and horsepower of the driver have a direct bearing not only on the capacity of the units but on the pressure output as well. Axi-compressors are identified as in the following example:

The size 175×30 unit serving the couch and transfer rolls at Glatfelter is a unit having rotors 30 inches in length and with the rotors' shaft centerlines spaced 17.5 inches apart. The same machine can be used for pressures from 24 inches of Hg to 18 psig with varying speeds from 500 to 1200 rpm, driver brake-horsepower ratings to 650 and capacities to 8000 cfm.

Quarry Compressors— From Stationary To "Portable"

G. R. SMITH

HOW PORTABLE can a stationary compressor be? Pose this question to personnel at The Carbon Limestone Company, Lowellville, Ohio, and the answer most likely would be: "Completely." The company has been in existence since the 1800's and is a large operation. It takes about 7000 tons of limestone from the ground each working day and annually moves some 2,000,000 cubic yards of overburden to bare the stone. Its main purpose is supplying flux stone for the myriad steel furnaces of nearby Youngstown, Ohio, generally regarded as one of the two most important steel centers in the U. S. Besides the flux stone, other forms of limestone and several by-products are produced.

To loosen this mineral, resting in a 22-foot-stratum under 95 feet of overburden, extensive drilling of blast holes is needed. These holes are drilled with compressed air.

Until 1953 this air came from a stationary compressor plant which fed air through steel piping to two working sites where quarrying is carried on independently of each other. Although the stationary compressors themselves were well suited to the operation, their network of piping became increasingly troublesome. It often needed to be moved to the next major quarrying area; additional line had to be added constantly; existing, rusted piping had to be repaired. When the situation finally demanded that a crew of three or four men be kept on this maintenance job all the time, the limestone company's managers began searching for a better method of delivering air to the drills.

These men knew what they wanted: two electric-driven compressors, portable, dependable, and capable of moving themselves and their hoses from one blast site to the next. Because there was, of course, no conventional portable compressor that would meet these needs, they looked to the available stationary units. Such a stationary would have to be compact so that it would operate from a relatively unstable mounting, and be unaffected by the abrasive air present in a quarry.

The compressor eventually selected for the unique task was Ingersoll-Rand's XLE. This is a rigid, 2-stage, motor-driven unit whose frame is its own internal piping. The "L" in the name comes from its L-shaped design; the vertical member is the low-pressure cylinder, and the horizontal one, the high-pressure cylinder. Where the two members of the "L" meet, the two pistons join connecting rods on a common crankshaft. As the air inside the frame flows from the low- toward the high-pressure cylinder, it moves through an integral intercooler. Chosen for The Carbon Limestone application were two 150-hp units. Each has a piston displacement of 973 cfm and supplies 100-psig air. Their low-pressure cylinders have 16-inch bores; their high, 10 inches.

The next problem was finding a suitable base for the compressors. After investigation, it was decided to use the running gear for the smaller, rearmost cargo trailers used by dual tractor-trailers, such as those most common in the extreme western U. S. The compressors were bolted to timbers mounted on the steel beams of the trailer frames. To provide protection from both flying blast rock and limestone dust, a rectangular sheet metal enclosure was built about each trailer. At the front a grille was placed to allow air to enter the compressor water cooler. A 30-inch diameter, 7-foot-long air receiver was put neatly under the bed of each trailer.

The compressor motors are 3-phase, 60-cycle, squirrel-cage induction units that turn at 585 rpm. They operate from a 2200-v line that is run to a tender atop the trailers. As air enters a compressor it passes through an American No. 2-OCH air filter that has weather louvres. The compressors have semiautomatic starting unloaders and 3-step control. There are Mercoid high-temperature shutdown switches on the discharge lines.

The next problem was finding a means to move the compressors the short distance from one blasting site to the next. A simple method was found, using the compressors' own air. Just above the point where drawbar joins trailer, an Ingersoll-Rand Size EU single-drum utility air motor hoist was installed. To move the vehicle, a cable from the hoist is run out to a stake driven into the limestone at the location where the trailer should next be. When the hoist is started, it winds in the cable and pulls the trailer forward to the stake.

Since their introduction in 1953, the XLE's have been in constant use and have offered their owners no problems. Maintenance, aside from routine care, has been almost nonexistent. One set of channels for one Channel Valve on one compressor has been the only item replaced. One of the compressors' chief advantages, according to the Carbon Limestone management, is their simple operation in winter. Because they are electrically operated, there is no problem of starting the units. And because they don't have gasoline or diesel engines, no long warm-up period is necessary. The problem of the certain amount of maintenance inevitably associated with such engines is eliminated.

The other operations at The Carbon Limestone Company quarry are equally efficient. Stripping of the overburden above the limestone bed, the first procedure in the task of taking the stone from the ground, is done by three large draglines. One is a 650-B Bucyrus-Erie with an 11-cubic-yard bucket and a boom 235 feet long, one of the longest in the world. Also used are a 9-W Bucyrus-Erie with an 8-yard bucket and 200-foot boom, and a 7-W Bucyrus-Erie having a 6 -yard capacity and 180-foot boom. The overburden averages about 95 feet in depth and because of the slight dip of the limestone stratum, it is increasing. To reach the stone, the draglines must pass through 24 feet of soil and hard-pan, 2 feet of sand-

REAR DOORS OPEN

Snugly positioned inside a trailer, this Ingersoll-Rand XLE provides portable air for blast-hole drilling in a limestone quarry. The compressor, its electric motor, and the air filter can be seen. Air lines feed out at the bottom; at upper right is the electric line.

FRONT VIEW

Above the point where the drawbar joins the trailer is an Ingersoll-Rand Size EU air-motor hoist that pulls the trailer ahead by taking in a stake-anchored cable. Under the trailer, and ahead of the rear dual tires, is a reel that holds wire for blasting. Workmen are loading holes at right.

stone, 25 feet of shale, about 2 feet of Kittaning coal, 4 feet of fire clay and another layer of shale 36–38 feet deep. The width of each cut is about 90 feet, the widest economically practicable.

With the stripping complete, wagon drills punch $2\frac{1}{2}$-inch holes into the limestone. The stone is geologically known as the Vanport seam of the Allegheny group, Pennsylvania system. It has a uniform depth of about 21 or 22 feet with the upper 12 to 15 feet consisting of gray, highly fossilized stone, and the lower part a harder, bluish variety. Drill holes are placed on 9-foot centers and staggered row to row. First into each cavity goes 9 pounds of 75-percent gelatin dynamite (which makes a clean break at the bottom of the shot); then comes about 35 pounds of ammonium nitrate usually Hercules' Dynatex; then another primer is added, meaning that each hole is charged both top and bottom. Using 220-v power through wire stored on reels attached to the compressor trailers, the central loads are shot first. Delays of 1, 2, 3, 4 and 5 milliseconds are used as the blast moves toward the periphery. A weakened area is created when the central holes are shot, and the succeeding explosions fracture rock more efficiently because there is a loosened core to break toward. Two 4-yard 4161 Marion shovels put the rock in rail cars.

Moving the limestone to the crusher keeps the company's own narrow gauge railroad busy. On the closed loop of 4.5 miles of track surrounding the workings are seven 25-ton diesel locomotives. Each pulls fourteen cars; every car has a capacity of 11.5 tons. The cars dump into a primary 42-inch gyratory crusher which is the first processing plant. Secondary crushers reduce the limestone to 1×5-inch pieces or smaller, and the larger of this material goes to bins for shipment as blast furnace flux stone. Minus-1-inch screenings go to the washing plant where sand is removed and the remainder is screened into as many as twelve sizes for use in concrete aggregate. A pulverizing plant also receives part of the flux stone screenings, and grinds two grades of agricultural limestone. Before this stone is ground it is kiln-dried.

Other products coming from the quarry are the fire clay and coal, part of the overburden. Some of the coal is used in kilns by the company and some is sold. The best quality fire clay is also sold.

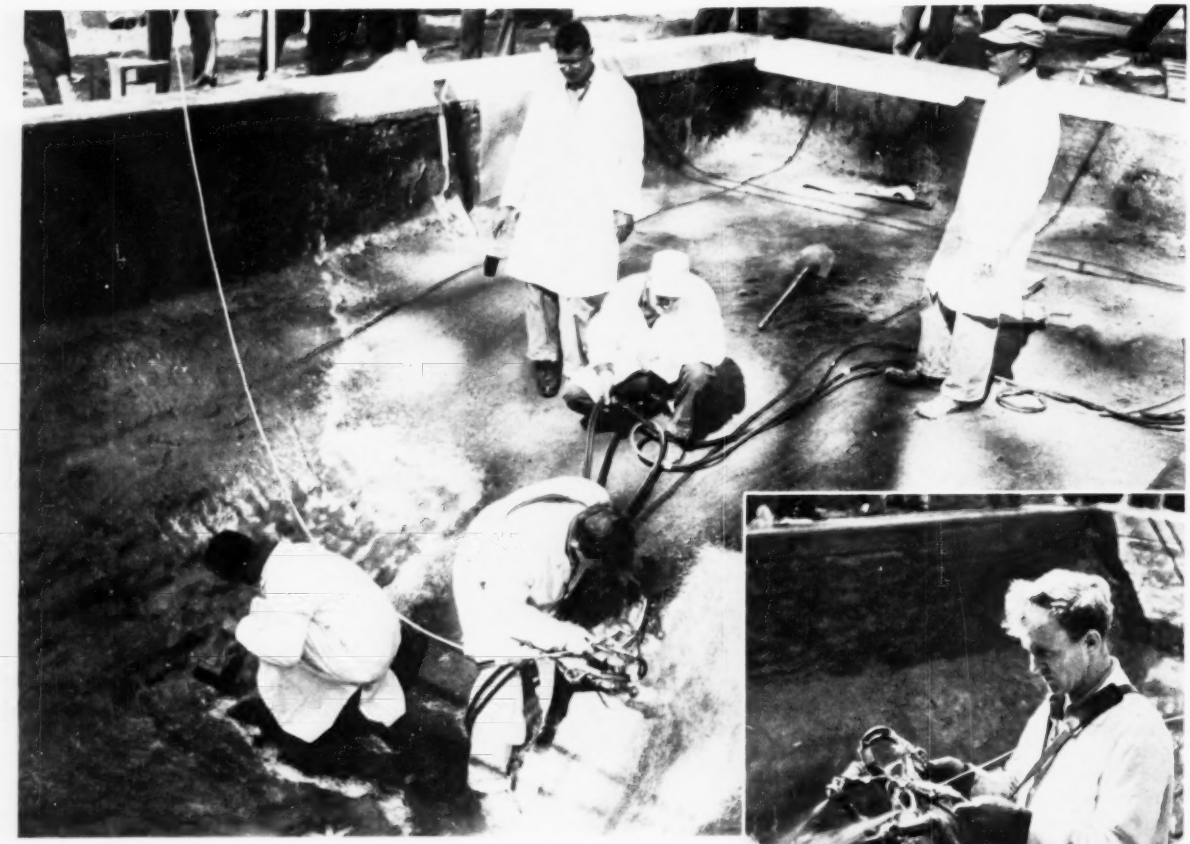
QUARRY AERIAL VIEW

At left, the advancing edge of The Carbon Limestone Company quarry has produced this miniature mountain range of stripped overburden. In the foreground a Bucyrus-Erie dragline with a huge 235-foot boom wrestles with a bank of soil. At upper right can be seen the bench of limestone being worked.

Company's Early History

The story of The Carbon Limestone Company began in the middle 1800's when a Hiram Parks began quarrying the mineral in Lawrence County, Pa., for flux stone purposes. The iron industry had begun in 1803 when the ore was first mined in the area. Limestone and coal also were found and were used in the production of pig iron. Although the iron ore deposits were soon depleted, the steel industry has remained. Quarryman Parks eventually sold his property. About 1887 John A. and Edith A. Logan formed a partnership, called Carbon Limestone Company, inheriting the property from Edith's father, Chauncey Andrews. The name changed just slightly in 1894 when the concern incorporated and renamed itself The Carbon Limestone Company. Its lands, part owned and part leased, extend over 2500 acres next to the Pennsylvania-Ohio state line. The 2-mile-long quarry is in Poland Township, Mahoning County, Ohio; the processing plant and the company's comfortable offices are in Mahoning Township, Lawrence County, Pa. Youngstown and its steel mills are about 10 miles northwest.

The company has been fortunate in that its managers through the years have been foresighted, aggressive men. Evidence of this is seen in the fact that, of the many limestone operations once working in the area, The Carbon Limestone Company is one of three that have survived. The company employs a total of about 200 persons. The current president and chief executive officer is George H. Donaldson; vice president of operations is Robert H. Chisholm; Philip E. Heim is vice president, sales; Urban F. Masson is general superintendent, and George V. Kuhn, who has been with the company since 1928, is quarry superintendent. Thomas W. Pfahles is chief engineer and Walter S. Harmon is maintenance superintendent.



"We may not find
what we are looking for,
but we never find anything
unless we are looking for something."

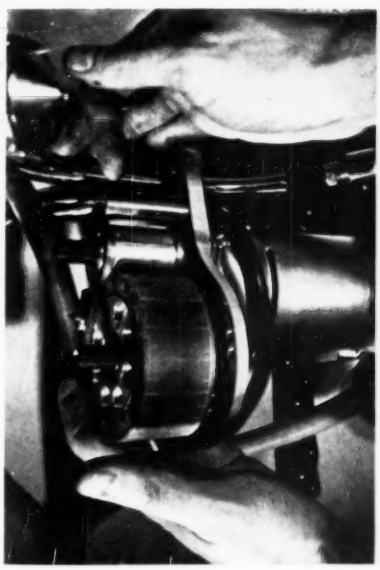
—SLOSSON

The Realm of Research

S. M. PARKHILL

FIBER-RESIN DEPOSITOR

Close-up view of the Depositor (right). The catalyst and resins issue from the two adjustable nozzles. The center section consists of the "cutting" mechanism through which fiber glass roving is passed. The entire unit is adjusted so that the streams of broken fiber, catalyst and resin meet and mix in midair just prior to hitting the surface to be coated, as can be seen in the pictures at left.



CUTTER CLOSE-UPS

The "cutting" mechanism is shown (left). At the top is a metal cylinder that has razor blades clamped to it. Beneath it, is a silicone rubber covered roller. The roving passes between these two rollers and is snapped into lengths that may be varied from $\frac{3}{4}$ inch to 4 inches in length. The variation is created by changing the number of the blades, as shown above.

INDUSTRIAL RESEARCH, as it is generally thought of today, came into focus just prior to World War I. Scientists were being used in teams in Germany, and large-scale electrical, chemical, and optical laboratories were organized. In America, some industries—General Electric Company, Bell Telephone Laboratories, Inc., Eastman Kodak Company and Standard Oil Company (Indiana), to name a few—were establishing research laboratories of their own. With the outbreak of the war, important foreign sources were severed from American industry. The need for research became readily apparent; and to coördinate the program, the National Research Council was created.

Industrial research had a phenomenal growth—by 1958, it was costing an estimated $10 billion, 4 percent more than during the preceding year. It is continuing to expand. *Fortune* predicted that U. S. spending for research would be about $120 billion during the 1960's, almost twice that forecast for the 1950's. This money is being spent in two major areas: for "internal" research, that is within industries' own laboratories and subsidiary research companies; and for "external" research, by outside agencies such as universities, foundations, nonprofit laboratories and independent research companies.

Rand Development Corporation, Cleveland, Ohio, is one of the last-named groups. It is a profit-making company with its own research staff, while at the same time it is an independent agency available to all other industries. The company's dynamic nature is a reflection of its president, Dr. H. J. Rand. He is one of the few Renaissant men in our century, with interests balanced in the fields of industry and medicine. Dr. Rand, son of industrialist James H. Rand, studied at the universities of Vienna and Berlin, and holds an honorary degree from Bethany College.

Man must specialize to keep pace with the ever-broadening scope of knowledge. The resultant scientist-inventor-specialist, such as Dr. Rand, assumes a major role in today's economic struggle. However, there is little room for such a man to work in a hermitage as he once did. Free association between specialists from various groups, as well as within each group itself, is essential to a free industrial society.

Aware of this, Dr. Rand currently employs about 100 persons—plastics, metallurgical, and mechanical engineers; scientists of all types; and "just clever people"—in the Cleveland laboratory. The corporation's interests are broad, competing successfully with nonprofit laboratories. Since it was founded in 1948 Rand Development Corporation has expanded to include offices in New York City, Washington, D. C., and, most recently, Moscow, Russia. Its subsidiary companies include Airmass, Inc., and Madaus-Rand, Inc., and Rand-Goetze Corporation of Germany.

Plastics Depositor

One of the company's more interesting projects was the perfection of a pneumatic gun for spray-up plastics applications. In operation, it shows astounding labor and material cost savings over hand lay-up methods.

Called a Rand Fiber-Resin Depositor, it was the invention of David F. Anderson. He began work on it in 1950, while vice president and general manager of Fiberlast of Canada, Ltd. Canadian Ingersoll-Rand Company, Ltd., secured an interest in the device, backing Fiberlast until November 1957, when Rand Development Corporation gained its interest in the project. (There is no relationship between the two "Rands.") Rand completed the work and now holds uncontestable patents in both the United States and Canada.

The 9-pound gun resembles bicycle handle bars, with a pair of adjustable

W. J. Rand

nozzles, one on each side of an electric "cutter." The "cutter" posed a particular problem for Rand. Tools, even with tungsten carbide edges, wear particularly fast when working with fiber glass. Blades dull quickly and require frequent honing. Rand decided to break the glass rather than to cut it.

The present "cutter" consists of two tangential cylinders. One is of metal in which single-edge safety razor blades are clamped, and the other is covered with a silicone rubber. These rotate in opposite directions, and as fiber glass roving passes between them, the thin razor blade edges press the fibers into the soft rubber, causing them to bend at a sharp angle and break. Since the snapping is not dependent upon the blades' sharpness, a single set of blades lasts for hundreds of pounds of roving. When they must be replaced, the job is simple and inexpensive.

From one to five strands of roving can be broken at a time to preselected lengths, varying from $\frac{3}{4}$ inch to 4 inches. Both continuous and spun roving can be used.

Gummy polyester resins and a catalyst, fed from pressurized tanks or by pumps, issue from the guns. Air is used at a rate of 10 to 35 cfm and at a pressure 90 psig. Regulator valves control the rate of delivery.

The guns are mounted on ball joints for easy positioning. They must be arranged so that the resins, catalyst and fiber glass are mixed in midair just prior to hitting the surface to be coated. (The plastic will adhere to most substances.) This results in less than 1 percent of void areas.

While the surface is wet, the reinforced plastic can be smoothed with paint rollers or ordinary paint brushes. (If specified, the natural rough surface may be retained.) One man operating a Depositor can keep two to three men constantly busy with rollers. Once applied, the plastic is allowed to set for 2 hours. When dry, it has the strength of steel or concrete, but with the advantages of not springing or cracking under extreme stress. It can be fire resistant too, and can be screwed, nailed or sawed easily.

This spray-up process can replace hand lay-up methods, wherein layers of woven glass fabric are cut and applied, covered with resin and rolled—a messy and time-consuming job. The spray-up method is faster, cleaner, cheaper and more flexible in its application. The products that can be produced are of an endless variety.

Spray-Up Applications

A pioneer user of the Depositor is Larson Boat Works, Inc., Little Falls, Minn., which claims a 50-percent labor cost savings and a 3-percent savings in material costs. Formerly, a 19-foot boat required 40 hours to construct; now it takes only 19 hours. So successful was the device, the entire 1958 line was fabricated this way.

Wallace Metal Products Company, Richmond, Ind., uses the Depositor to make coffins, and claims a 50-percent labor and material savings. Other applications include the making of water ski, shower stalls, machinery housings, bathroom fixtures, and truck fenders.

One of the most dramatic uses was the making of a swimming pool. Last year's first demonstration took place at the Rand home in Cleveland. Three men did the job—one operated the Depositor, the others were equipped with rollers. Using one Depositor and a single-stage, air-cooled Ingersoll-Rand 3R-36 Spot-air portable compressor, the 16x32-foot pool was laid in only 8 hours. It was estimated, at the time, that with a second gun, the lay-up period could have been reduced by 50 percent.

The Depositor is a popular item. In fact, the latest Rand Development shareholder report stated that a program is now underway to select and appoint state and regional representatives. A foreign sales representative has also been appointed.

Current Projects

A Cooper-Rand electronic speech aid permits patients who have had their larynx removed to talk shortly after the operation. It consists of a microphone, an amplifier that draws 2 to 4 milliamps

Of Business and Research

How important is the national program of research?

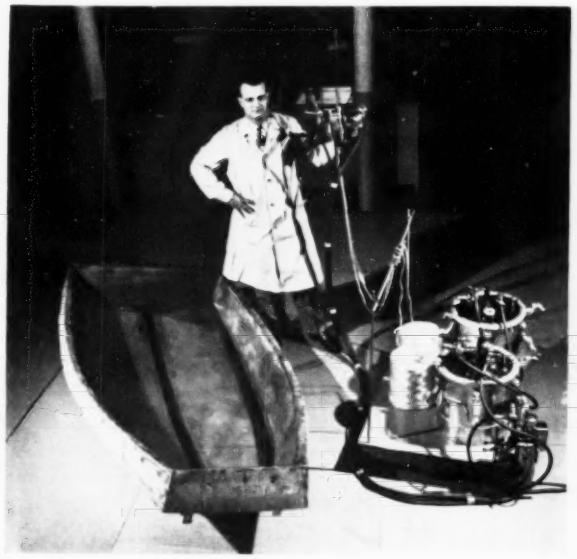
Research is not only critical to the national defense—an important factor in its birth—but it is essential to a continuance of American economic progress, based as it is on private industry. From the standpoint of the individual company, research promotes stability and long-range growth.

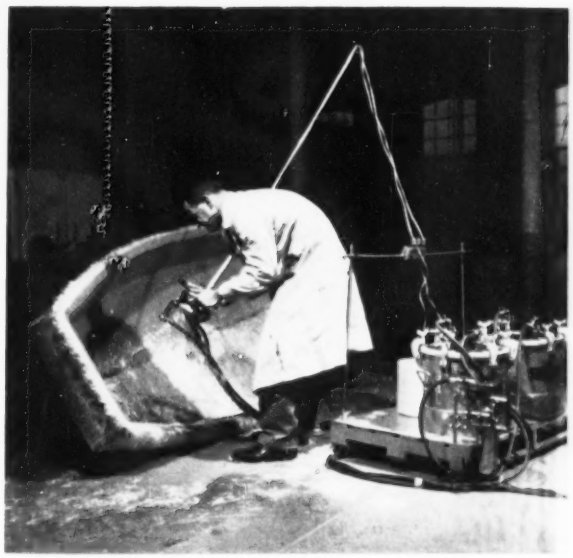
What amount of research should a corporation use?

Answering this is not easy, for it is based on many factors. Research generally is stimulated by competition, but the extent of it is based on the availability of company resources, immediate needs and future plans, and the nature of the company products, according to the National Science Foundation. The benefits derived from research must also be weighed, for research can stimulate sales and reduce manufacturing costs, reveal new products, re-evaluate current methods and processes, and can open new avenues for investment. With such a vitality, research must be considered a part of corporate management organization, just as are sales, finance, production and promotion.

When should independent research laboratories be used?

Although many companies have their own adequate research staffs, they still have an important need for independent research firms. When a project requires expensive, specialized laboratory equipment; where there is a lack of a particular type of scientist, or of sufficient basic data; when company laboratories have reached peak workloads; where quality is to be checked for buyers and sellers or disputes and litigations require refereeing and testifying; when staff conclusions need checking; and when new fields are to be explored before committing a company staff and new-equipment expenditures to a proposed project—then, the help of an independent research company is invaluable.





TO MAKE A DINGHY

At the left can be seen the essential equipment for making a plastic boat using the Rand Fiber-Resin Depositor. The mold at the left is painted a blue and the resin is dyed a yellow color so that the work can be more easily followed. Two spools of roving are used, and the resin and catalyst are fed from pressurized tanks. The other picture shows the first layer of plastic being sprayed up. The roving comes from the spools, through eyes and is carried over a wire strung overhead. When the plastic has been applied, it will be rolled and two more coats will be added. The rough side edges will be trimmed with a small air-powered saw when the plastic has set. This is the final step, and the hull can be lifted from the mold.

on stand-by, mercury batteries and a miniature speaker of the type used in transistor radios. Fifty percent of the Rand profits from the aid are passed to the Cleft Palate Clinic in Lancaster, Pa., whose director, Dr. Herbert Cooper, suggested the device to Dr. Rand.

Airmass, Inc., an 80-percent-owned subsidiary (up 8 percent from 1957), manufactures alternating pressure point pads to prevent bedsores. The mattress consists of two sets of inflatable tubes, and a valve-and-pump mechanism to alternately inflate them. Thus no single area on the patient's body is continuously subjected to body pressure.

Convacard is a heart tonic. Its affect is similar to that of digitalis, but without the cumulative toxic side affects. It is a product of Madaus-Rand, Inc., a patent and process holding company jointly owned by Dr. Madaus & Company, Cologne, Germany, and Rand Development Corporation.

Rand-Goetze Corporation (Rand owns 50 percent of Goetzewerke of Germany) is responsible for a resilient wheel that consists of two cylindrical rubber sleeves between the rim of the wheel and the hub. This isolates the rim from the center, preventing transmission of high-frequency vibrations and shocks to the wheel and axle. It is especially suited to vehicles with little or no suspension.

Important work is also being done by the corporation in leukemia and cancer research.

In addition to the foregoing "internal" projects, Rand Development Corporation, in its role as an independent research company, has a vast number of "external" research projects that it has undertaken for its client-companies. They are excellent examples of the value such a corporation can be to other industries. Dr. Rand's opinion about this subject, as well as about research in general, is best summarized by quoting his address before the American Life Convention (October 1957):

"Research is the best insurance any business can have. . . .Research for the corporate executive is insurance against rising labor costs, obsolesence and the accelerated tempo of the interplanetary age which we have entered. . . .Companies that don't keep pace with the new discoveries. . .new markets, new production techniques and new products are on the road to oblivion."

The following three cases are illustrative.

One client-company's plant engineer wanted to find an economic way to dispose of waste after a steel cleaning process. As a result of Rand's investigation, the process itself was changed. The client has since reported not only a substantial production cost savings, but a better product.

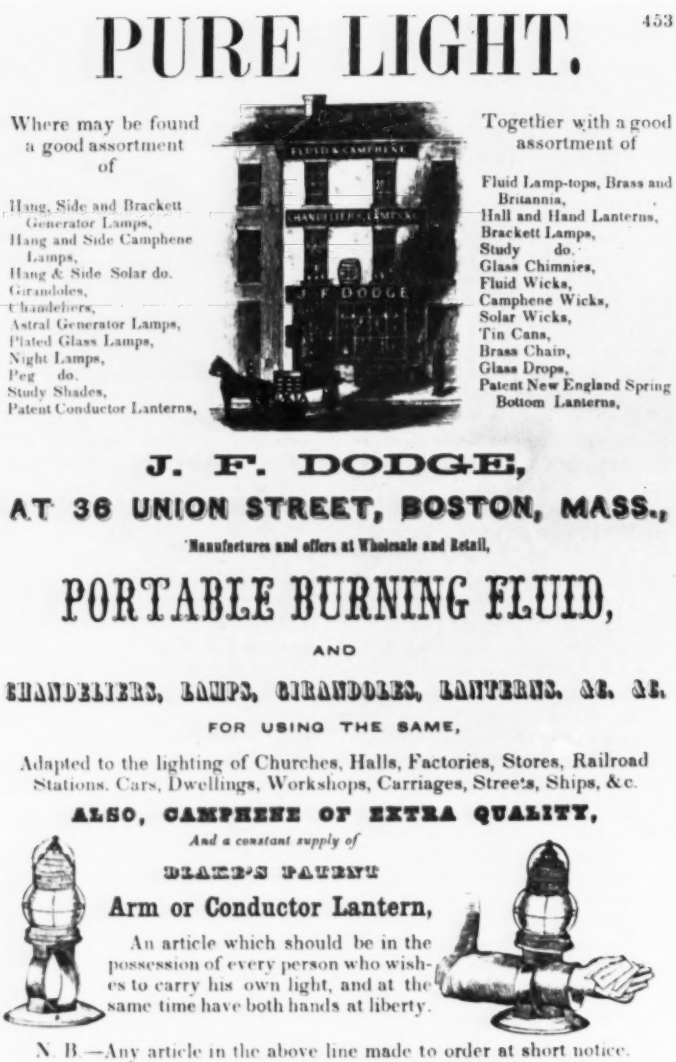
A second case arose from a client-company's competition. The objective here was to find a process that would apply plastic to paper, maintaining its form, color and clarity. A new type of plastic was selected, Rand supervised the necessary retooling, and the client went into production to meet the peak season, keeping abreast of its competitors.

In an attempt to increase production on one phase of a home appliance assembly operation, it was found that a time-savings could be made, but that it would be expensive and complicated. Rand researchers continued to study this client's problem. The result was a new appliance, based on the principle of the old one, that performs the same function. More important, it is constructed better and can be produced at a lower cost.

Thus, Rand Development Corporation is not only a profit-making company in its own right, but an independent research laboratory for other industries that care to take advantage of its services. It is an excellent example of scientific cooperation, and is, in short, an important facet in American growth.

Whales and Rockets

PETER SLEIGHT


PURE LIGHT.
453
Where may be found a good assortment of
Hang, Side and Brackett Generator Lamps,
Hang and Side Camphene Lamps,
Hang & Side Solar do.
Girandoles,
Chandeliers,
Astral Generator Lamps,
Plated Glass Lamps,
Night Lamps,
Peg do.
Study Shades,
Patent Conductor Lanterns,
Together with a good assortment of
Fluid Lamp-tops, Brass and Britannia,
Hall and Hand Lanterns,
Brackett Lamps,
Study do.
Glass Chimnies,
Fluid Wicks,
Camphene Wicks,
Solar Wicks,
Tin Cans,
Brass Chain,
Glass Drops,
Patent New England Spring Bottom Lanterns,
J. F. DODGE,
AT 36 UNION STREET, BOSTON, MASS.,
Manufactures and offers at Wholesale and Retail,
PORTABLE BURNING FLUID,
AND
CHANDELIERS, LAMPS, GIRANDOLES, LANTERNS, &c. &c.
FOR USING THE SAME,
Adapted to the lighting of Churches, Halls, Factories, Stores, Railroad Stations. Cars, Dwellings, Workshops, Carriages, Streets, Ships, &c.
ALSO, CAMPHENE OF EXTRA QUALITY,
And a constant supply of
BLAKE'S PATENT
Arm or Conductor Lantern,
An article which should be in the possession of every person who wishes to carry his own light, and at the same time have both hands at liberty.
N. B.—Any article in the above line made to order at short notice.

Photo, Standard Oil Company (N. J.)

FORERUNNER OF KEROSINE

Camphene, one of the more noxious compounds invented to replace whale oil as an illuminant, as advertised in 1855. Camphene is a mixture of turpentine and alcohol, but is evil smelling and likely to explode.

TO THINK of a widow's walk on a Nantucket home and a control-center blockhouse at Cape Canaveral in the same context is not as strange as it might seem at first. Nor would it be foolish to speak of the "lamps of China" together with the jet stream. All are links in the great kerosine cycle.

A sharp need for a new type of illuminating oil was felt in the mid-1800's. Until then, whale oil had served the purpose, but its price was rising beyond the consumer. The whaling fleet was gigantic, the industry itself was huge, and the killing of whales had become wanton. At its zenith, in the 1850's, the ships of the American fleet totaled 735, outnumbering the combined fleets of all other nations. They were valued at more than $21 million, exclusive of outfits and supplies. The entire capital in whaling and its allied activities amounted to about $40 million.

As early as the 1700's, whales were no longer found in coastal waters. Vessels were forced to sail further, moving to the cold oceans, the southern Atlantic and, before 1800, to the Pacific. Voyages lasted 3 to 6 years and ships had to be provisioned accordingly, which added considerably to expenses, as reflected by the rising price of the oil.

Oil from the head of the sperm whale, the most valuable, generally sold for more than $2 a gallon, even by 1846. At times, a $5-per-gallon price was realized. With fully grown bull sperm whales yielding as much as 145 barrels* of oil, the value of the crude catch during the 2 decades following 1840 averaged $8,000,000 annually.

Coal Oil

Necessity drove men to search for less expensive illuminating oils. Dr. Abraham Gesner, a Canadian physician and

* The petroleum industry's barrel today contains 42 gallons, as established by the early whalers' barrels.

geologist, worked with coal oil. He called his product Kerosene, based on the Greek *keros*, wax, because of the wax-like paraffin that occurred during the processing. The Greek for oil, *elain*, was suggested as a termination for the new trade name to imply wax-oil, but was rejected in favor of *-ene*, the ending of the then-common illuminant, camphene. This, thought Dr. Gesner, would make his product seem more familiar to the general public and would indicate its principal use. (Camphene was a purified oil of turpentine that tended to smoke unless burned in a lamp with a strong draft. It was also mixed with alcohol, but the resultant illuminant was highly volatile, very inflammable and explosive.)

The trade name quickly became generic with a growing popularity for Kerosene, and frequent misspellings occurred. Most general was kerosine, which was later adopted by standardization committees of the American Society for Testing Materials, the American Petroleum Institute and the British Institute of Petroleum. Nevertheless, Webster and Oxford dictionaries show a preference for the original spelling, *kerosene*, although they concede that *kerosine* is preferred by "certain technical authorities."

Gesner's patent indicated that his Kerosene was made from a mineral erroneously called Albert coal for the county in New Brunswick from which it came. It was so called because it resembled a bituminous coal. Gesner said that although it had the superficial qualities of coal, its jet-black, pitch-like properties were more those of asphaltum. Nevertheless, Albert coal it was called for 3 decades. Herbert Abraham's *Asphalts and Allied Substances* (1945) indicates that Albert coal is now called albertite, a generic term embracing the entire class of asphaltic pyrobitumens, thus substantiating the doctor.

Dr. Gesner moved to New York early in 1853 where he applied for American patents. By March, he had started to organize a company to process not only Kerosene, but naphtha, illuminating oils, paraffin and other petroleum products as well. To raise the necessary money for the venture, he had published a prospectus describing the material to be used, the process involved, and the various products obtainable from it. The brochure stated that $43 worth of products could be produced from each $5 ton of Albert coal. To form a Joint Stock Company with a $100,000 capital, 1000 shares were offered at $100 each.

A group of enthusiastic New York business men furnished the required capital, and the company was established early in 1854 at Newtown Creek (Queens), N. Y., as the North American Kerosene Gas Light Company. In 1863, it was known as the New-York Kerosene Oil Company, Cozzen & Co., Mgrs.; 2 years later it was called Queens County Oil Works, R. W. Burke, Agent. Then, in 1876, the firm was purchased by Charles Pratt & Company, a subsidiary of the rapidly expanding Standard Oil Company, New York. The facility was disbanded as the Socony Queens Works in May 1952, and the equipment was purchased by a junk dealer.

Photo, Socony Mobil

ZENITH FOR KEROSINE

This advertisement appeared in newspapers and magazines, and on trolley cars. It advertised Astral Oil, one of the many Standard Oil brand names for kerosine during its first great popularity.

According to the Gesner patents, raw material was placed in an iron retort and subjected to a destructive distillation. Resulting vapors were bled through water-cooled pipes and condensed. A light fluid and a heavy, tar-like liquid remained. The latter was drawn off, leaving the light fraction, which was again distilled. The resulting condensate from this was mixed with the first distillate; heavier liquids after the second distillation were mixed with those of the first.

The light liquid was next agitated and treated with a 5- to 10-percent solution of sulphuric acid. After standing about a day to let the impurities settle, it was drawn off and mixed with 2-percent (by weight) calcined lime to absorb water and neutralize the affect of the acid. After another agitation, the product was fractionally distilled into three grades of Kerosene—all of which fall within today's gasoline cut.

Grade A, with a boiling point of 150° F and a specific gravity of 0.75, was too volatile to be safe in lamps. It could be burned by vaporizing it with a current of air in gas jets. Grade B had a boiling point of 250° F and a specific gravity of 0.775. It was moderately volatile and flammable. It could be burned in a lamp or mixed with Grade C, which had a boiling point of 350° F and a specific

Photo, Standard Oil Company (Ohio)

TO SEE UNDERGROUND

Two kerosine lamps for miners. They were made nearly a century ago by Standard Oil of Ohio.

gravity of 0.8. This held the most promise as an illuminant.

The North American Kerosene Gas Light Company had a 5000-gallon-per-day output and was valued at $1.25 million. Soon, the price of the coal oil was raised to $1.15 per gallon, which was still less than that of sperm oil, while costs of production were reported at only $0.63 per gallon. Gesner's venture had proved successful as had been predicted in his prospectus.

Competitors came. One was James Young, of Bathgate, Scotland. He produced a paraffin oil illuminant from crude oil seeps from a coal mine. Because the supply was inadequate, he obtained a British patent in 1859 to distill oil-rich cannel coal. Young found a ready market for his coal oil in the United States, and manufacturing licenses were granted on both sides of the Atlantic at about the same time Gesner was culminating his experiments.

Young is given credit for establishing the shale-oil business in Scotland. Because of his management prowess, good patent position (established in 1850) and technical achievements, all coupled with persistent historical confusion as to the date when coal was first refined into an illuminating oil, he is better known today than is Gesner. It took those who followed Gesner with improved refining techniques to bring his work and dreams into proper perspective.

Carbon Oil

Meanwhile, a drug store operator named Samuel M. Kier was refining crude oil, calling it carbon oil. Kier had 400-foot-deep brine wells from which he obtained his crude. Although his small, 5-gallon stills of the 1850's yielded a poor quality illuminant that smoked profusely, he is credited with the first refinery. Selling his oil product as a medical cure-all: *Kier Rock Oil—Celebrated for its wonderful curative powers—a natural remedy—produced from a well 400 feet below the earth's surface*, the supply outgrew the demand. Kier began investigating his carbon oil as a possible source for kerosine. He was successful, a suitable lamp for burning it had been developed, and he went into production of the popular illuminant.

Colonel A. C. Ferris adapted the design of Kier's stills and became one of the largest early refiners and dealers. More important, the crude Ferris obtained from oil seeps in Europe, California and the East Indies, was paid for at a rate of $20 a barrel. This established the market price for crude oil. When Colonel Drake brought in his famed well in August 1859, Ferris and Kier joined hundreds who flocked to Titusville, Pa., to buy the crude at this established price.

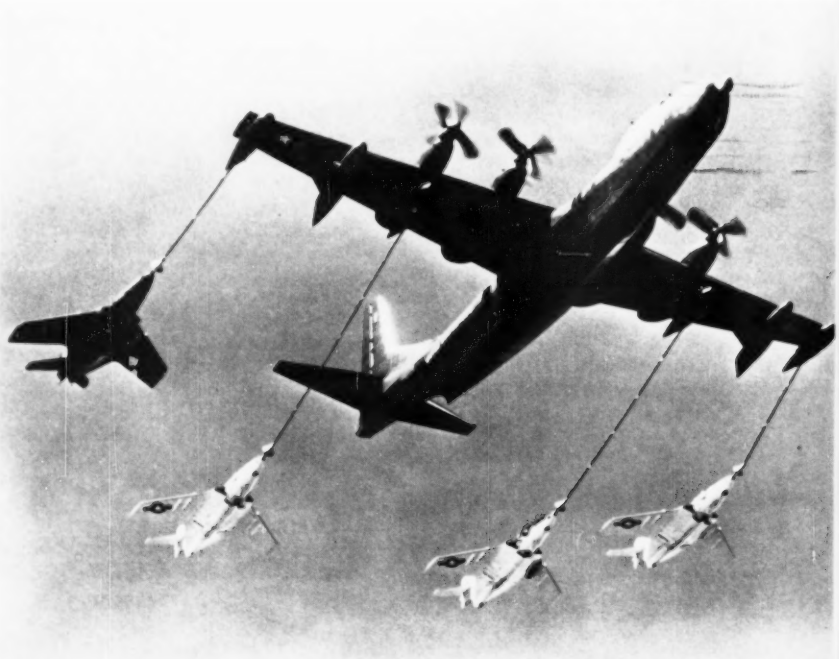
Obtaining kerosine from coal and shale had been a costly process, even though the end product was less expensive than whale oil. It was cheaper to make it from crude oil, but seeps had been inadequate to meet the ever-increasing demand for kerosine. With Drake's commercially successful well, kerosine could be produced in quantity and at a reasonable cost. It became the first refinery product for the petroleum industry. Refineries turned out about 75 percent kerosine and only 10 percent gasoline. Oils, waxes and lubricants constituted the remaining 15 percent.

A typical petroleum refining batch operation started with the vaporization of Pennsylvania Grade Crude at 180° F. As the temperature of the still was gradually increased to 1000° F, the lightest product, gasoline, was given off. This was followed by naphtha, or benzene. Both were generally discarded as waste. The next fraction was the

REBIRTH OF KEROSINE

Airborne fuel lines simultaneously refuel four Navy jet fighters from tanks of a Convair R3Y-2 Tradewind. It can carry enough fuel for eight fighters, which are refueled in less than 5 minutes with a kerosine-type product.

Photo, U. S. Navy



sought kerosine. This was treated with sulphuric acid and caustic soda as had been Gesner's coal oils. It was then washed with water. Treating in agitators was aided by compressed air to assure a complete mixing. After treating, the product was put through a bleacher to improve its color and remove the light ends by vaporization. Grades were based on both color and specific gravity.*

Coal oil refineries had become popular throughout the North American continent. By the time of Drake's first well, the *Scientific American* numbered 30 facilities in the northeastern states, including West Virginia and Ohio, and noted a combined annual production of 22,750 gallons. The number had increased to 50 by 1861, according to Gesner's famed handbook, *A Practical Treatise on Coal, Petroleum and Other Distilled Oils*, which went on to mention fifteen other plants capable of producing kerosine from crude oil. Thus, 2 years after Drake's discovery, a definite trend to the production of kerosine from oil was appearing.

So the kerosine industry began. Had not the cost of whale oil forced men to look for a new means of lighting, the youthful petroleum industry, which kerosine had given the initial push, might not have flourished until many years later.

Competition

The first major competition to the American kerosine market came from Russian companies that were backed by the influential House of Rothschild in France and the Nobel family of Sweden. Because Russian crude contained little sulphur and no paraffin, it made a better kerosine than did the American oil. With the development of a continuous distillation process, kerosine could be made at a very low cost, giving Russia an edge on the European market. With the advent of ocean-going tankers in 1885, other American customers were lost.

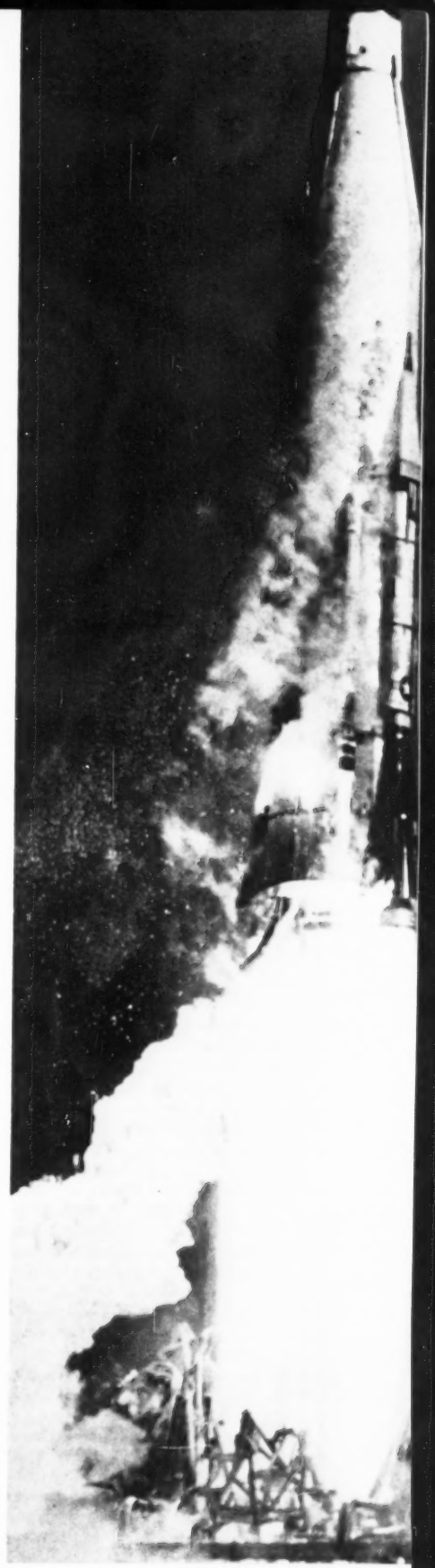
American shipments to the East suffered particularly. For example, 100 percent of the kerosine used in the Orient in 1880 came from the United States, but by 1885, it fell to 10 percent. The famous little tin-based kerosine lamps for China were offered at a nominal price to induce more trade, but failed to stimulate the Eastern market.

Kerosine was relatively short-lived, for another type of competition was growing. The advent of the automobile and the internal combustion engine brought a greater demand for the once-wasted gasoline fractions. Kerosine became a minor product. By 1911, gasoline production exceeded kerosine for the first time. Kerosine was relegated to stoves, country lighting and the like; and even this was soon supplemented with the development of an automatic oil burner in 1917, and by the increased use of natural gas. By the end of the First World War, there were 250 refineries in the United States, running a reported million barrels of crude daily. By 1918, gasoline output from them reached 85 million barrels, or about twice the amount of kerosine.

OFF THE PAD

Kerosine combined with lox (liquid oxygen to make the kerosine burn at high altitudes) combine to provide the fiery thrust needed to lift this 7-story Atlas ICBM from Cape Canaveral, Fla. Frost encrusting the liquid oxygen tank is shown being shaken off as the missile rises.

Photo, Arthur D. Little, Inc.



Jet Fuel

It was during the Battle of Britain in 1941 that the jet age was born and the need for kerosine-type products began to redevelop. Frank Whittle, a Royal Air Force officer, built a jet engine based on a 28-year-old idea. His engine gave aircraft a speed of 400 mph. Rapid advances in jet design followed. Today commercial jet aircraft fly at 600 mph at altitudes of 40,000 feet, consuming kerosine at the rate of 2200 gallons per hour.

It has been said, "kerosine used in jets is to the old fashioned lamp kerosine as the 1960 model Lincoln is to a Model T Ford." The fuel must be more highly refined than the illuminating oil, although it is thought possible that the familiar kerosine could be used successfully. Few impurities to disturb engine performance are allowed today, and no water vapor to cause engine flame-out is permitted—the results of new types of settling tanks and filters.

The new fuel—especially that used in military aircraft—is of the so-called "wide cut" variety, a combination of gasoline and kerosine that remains fluid at minus 58° F. (Early kerosine froze at minus 30° F.) It represents not only the results of extensive research performed by major petroleum refineries, associations and allied industries, but a rebirth of the importance of kerosine—a statement backed up by orders such as one for 4 billion gallons of kerosine, to be delivered over a 10-year period, recently placed by American Airlines. The petroleum industry must alter its production to meet these new demands. With elastic processing systems now in use, however, oil men feel their production patterns can be changed to meet any future requirements.

* Light and heavy refer to the gravity of the fluids, measured today by arbitrary units called API. These replace Baume units. A specific gravity of 1 is equal to 10 API; a specific gravity of 0.9 is 25.7 API, a medium oil. A light oil is one with a specific gravity of 0.8, or 45.4 API.

UNIQUE APPLICATION

The three men in the illustration at the left are pouring Johns-Manville vermiculite into a hopper. From it, the material is forced to the two workers standing on the distillation unit in the background by air at a pressure of 100 psig. A close-up view is below and shows clearly the spray nozzle of the cement gun. After the vermiculite was applied, a weatherproof coating of Insulkote was added.

Water For A Thirsty People

JUST beyond the Gulf of Maracaibo, off the coast of Venezuela, lies an important and colorful group of islands known as the Netherlands Antilles. They rise from the sea about 1200 air miles from Miami, Fla., and are divided into two principal groups of three islands each. One is known as the Lesser Antilles, or the Leeward Islands. It is made up of St. Eustatius, Saba and the southern (Dutch) part of St. Martin. These three are small dots in the Caribbean Sea, having a total land area of only 30 square miles. Of more importance are the islands of Bonaire, Aruba and Curacao, which gives its name to the group and which is the site of the bustling colonial capital of Willenstad. These three islands lie 500 miles southwest of the Lesser Antilles. They have a total area of 354 square miles and are sometimes called the Windward Group.

Curacao was discovered in about 1499 by Alonso de Hojeda. The Spanish occupied it in 1527, and The Dutch West India Company took control in 1634. The Dutch have held these island possessions ever since, with the exception of two periods—one in 1798, and the other, from 1806 to 1814—during which time the English were in command. Over the total 384 square miles is scattered a principally Dutch-speaking population of 183,714, according to the 1956 census. Corn, pulse and salt are produced; and the lands yield leached guanos and phosphatized rocks.

More important, however, is its principal industry—oil refining. Many Dutch, American and British petroleum companies have substantial interests in Curacao, including the famed Royal Dutch-Shell Group and Standard Oil Company of New Jersey.

The petroleum industry, in part, has been the reason for the islands' development and the brisk sea trade that has been built up between the Antilles and the United States and Venezuela. The fact that the islands form an excellent natural harbor has also been a major factor. Indeed, the shelter is so good, the islands have a historical reputation of being a favorite rendezvous for pirates and buccaneers. In the early years of World War II, the harbors became a haven for German warships. After the fall of the Netherlands, the islands remained loyal to the Dutch government in exile, as did so many of her possessions. Because of the refineries and the oil storage areas, they loomed as strategic allied naval stations. Some of the equipment used by the U. S. Navy to fortify Curacao was left as war surplus and has had a great deal to do with the fabrication of a sea water distillation plant on Aruba.

Contrary to expectation, life is not all Caribbean easy-goingness for the inhabitants and foreign residents. A recent, unprecedented dry spell on the island of Aruba, for example, threatened to leave the population without fresh water. It happened while Singmaster & Breyer, New York City engineers, were constructing a sea water distillation plant, and it caused the contractors to apply familiar pneumatic gunite techniques in an effort to get the plant into operation as quickly as possible.

The $11 million government-owned sea water distillation facility that was built is the world's largest single installation for producing fresh water from the ocean. It is also the first conversion plant to produce a marketable by-product—electricity.

Because of the urgency of the situation, it was decided to start fresh water production before the necessary insula-

REFERENCE MAP

The northern part of South America. The area indicated is generally that of the major oil-producing areas of Venezuela. The islands of the Windward Group (collectively called Curacao) can be seen spreading just to the northeast of the Lake Maracaibo Basin. The island of Aruba is the most westerly of the three.

tion was applied to the hot (215° F) surfaces of the installation's 35 evaporators, deaerators and main steam piping.

Each evaporator is 11 feet in diameter and 30 feet long. Applying block insulation to the cold evaporators before start-up, as would normally be the case, would have taken several months because of the size of the job and the many irregular projections on the distillation components. Another reason for the delay was that insulation specialists are scarce on the islands.

Knowing that granular insulation material is less expensive than the block varieties, and that untrained workmen can be quickly taught to apply it, Singmaster & Breyer found the solution to their dilemma in compressed air and a cement gun. With the development of the process, what is believed to be a unique method of blowing granulated insulation onto hot surfaces was established as a construction technique. The method promises substantial cost savings for similar work in low-labor-rated countries.

To do the job, a total of 80,000 pounds of lightweight Johns-Manville expanded vermiculite insulation was used. Vermiculite has a specific gravity of 2.3. It is a foliated mineral often used in making plasters and boards for temperature and sound insulation, and as a caulking compound filler material. It is an alteration product of biotite and other micas, and is found in Colorado, Wyoming, Montana and the Transvaal. When heated to 1750° F, the mineral expands with a vermicular motion, like a mass of small worms (and hence the name). The volume also increases as much as sixteen times, an indication of its light weight. Concerning its heat-resisting qualities, Brady's *Materials Handbook* states when it is mixed with 30-percent plaster of paris and 10-percent asbestos, it will withstand red heat without disintegrating. In pellet form, vermiculite is often seen being used for insulating between the inner and outer walls of houses and is frequently called mica pellets when in this state.

The vermiculite at Aruba was forced through a standard Gunite cement gun nozzle by air at a pressure of 100 psig. This was furnished by a war-surplus Navy portable compressor rated at 315 cfm. Water was introduced at the nozzle tip, and the resultant mix hit the hot metal surfaces with a high velocity.

Singmaster & Breyer engineers found that there was no rebound and no steaming. The adhesion was excellent—so good, in fact, that it can be removed only by using chipping hammers. The insulation was sprayed over the components of the distillation plant until an average thickness of 2 inches was obtained. Then workmen trowelled the surface smooth. Insulkote, a Johns-Manville heavy premixed asphalt, was next applied as a weatherproof coating.

In reporting to their home office, the contractors stated that the use of the vermiculite and the pneumatic spraying technique in this special instance not only solved the pressing time problem, but it also saved about 50 percent in costs, as compared with the more conventional low-conductivity block insulations that would have been applied had the dry spell not been so demanding.

Marauders of 1942

ARUBA is remembered by many as an attractive vacation area. Others recall it for the violent shelling of its refineries during World War II.

The German admiralty began its submarine campaign against western hemisphere coastal shipping in January 1942. U-boats operated in packs and took an ever-increasing toll of oil tankers. Supply ships were torpedoed in the St. Lawrence and the mouth of the Mississippi and oil refineries were shelled. By April, the number of ships lost was estimated to have surpassed the number being built. Official London expressed its grave concern, and Prime Minister Churchill summarized the alarm when he said, "We are strained to the limit."

The peak of the campaign came in May and June when merchantmen were being sunk on the average of three daily. Beaches along the coast of the United States were strewn with wreckage and blackened with fuel oil.

Aruba and Curacao early came under direct enemy attack as a part of this German campaign. According to some reports, the first U-boat shelled oil refineries on Aruba on January 16, just 5 days after the U. S. State Department had announced that troops had been sent to the islands to protect refinery interests. In the shelling, there were 23 reported dead and three tankers were lost.

Another attack came on the eighteenth of the month with the second shelling of Aruba and an attack on Port of Spain, Trinidad. By April, all the Netherlands forces on Curacao and Aruba were placed under the command of Rear Admiral Oldendorf of the U. S. Navy. Increased sea and air patrols and an extensive convoy system appreciably slowed the Germans, and by the end of 1942, that phase of the Battle of the Atlantic was being controlled by the Allied forces.

This and That

Computer Monitors Gas Meters

A computer system for on-line natural gas dispatching control, said to be the first such application, will be installed in the dispatching division of the Public Service Company of Colorado. The Libratrol 500 Process Control System will monitor gas flow meters at purchase points throughout the greater Denver area and the State of Colorado. It will compute the total hourly and accumulated demand for each hour of the day, thereby releasing the gas load dispatcher from the need of monitoring and calculating this data. Information furnished will be used by the dispatcher to control demand peaks, thereby avoiding higher charges than are absolutely necessary. To evaluate this demand it is necessary to record differential pressure, static pressure, temperature and specific gravity values at some fifteen metering stations. The number of readings—44 meters per station and the complexity of the calculations require 30 to 45 minutes of each hour when performed by the dispatcher. He can, in the future, use this time to make critical decisions regarding control of the demand, based on weather, industrial activity and other factors.

★ ★ ★

Old Tires Create New Safety

Long a child's pendulum of delight, when dangling from a rope tied to a friendly tree limb, the old automobile tire now has a more sophisticated use to youngsters at play. "Baldies" are pulverized and the ground tire stock is treated so that it will absorb asphalt binders. Then, reports Arthur D. Little, Inc., the stock is mixed with asphalt to produce a resilient surface-paving material for children's playgrounds. (This also takes care of the problem of disposing of old tires.) Many children are variously scraped, scuffed, cut, bruised and marked up by falls on hard, abrasive play areas. With the new surface coating, however, not even a dead-run slide for home base is cause for worry. The material is also useful for broad jump, high jump, and pole vault runways that, in the usual cinder form, garner many a shin splint or bruised heel. Any smooth base surface is said to be suitable to underlie the rubber-asphalt mixture, concrete or bituminous surfaces being ideal. A penetration base—4 inches of stone or slag for drainage, rolled and emulsified with asphalt—may also be used. After the rubbery surface is applied, it is allowed to set for 3 or 4 hours and rolled. About a week's curing is needed before use. Such safe play installations are in use in eight states and Canada.

★ ★ ★

Republic's Space Chamber

The lowest pressures on earth—for a human environment—will be present in a space chamber to be built for Republic Aviation Corporation. The vessel will simulate space at a distance of 150 miles above the earth and will be installed in 1960 in Republic's new $14 million astronautics research center. Space suits will be tested in the room, which will also be used to investigate physiological and psychological reactions of man at such heights, and to develop materials and components for space vehicles. The chamber will be 14 feet in diameter and 30 feet long with a weight of about 30 tons. Special vacuum pumps will reduce the atmosphere to the extreme low pressure of outer space. The main area, where men will be tested, is to be cylindrical, 26 feet long and 13 feet in diameter. At present, the greatest distance into space man has gone in simulation chambers is somewhat more than 38 miles. The new Republic research center, now under construction, will house seven specialized space laboratories, and will employ 400 scientists and engineers.

★ ★ ★

Coal Mine For Gas Storage

Conversion of a coal mine to a natural gas storage vault is being undertaken for the first time anywhere in the world by Public Service Company of Colorado. The site is the Leyden Lignite Mine, 7 miles northwest of Arvada. From 1903 until the mine was abandoned in 1950, approximately 6,000,000 tons of coal were mined, leaving a cavern of some 150 million cubic feet. It has been estimated that 3 billion cubic feet of natural gas can be stored in the old shafts under pressures up to a maximum of 300 psig. If preliminary tests reveal the mine to be suitable, the cavern will be developed to ease cold-weather, peak-demand periods in the Denver area. It has been estimated that the testing phase of the operation will cost $352,000, and, if successful, development will require an additional expenditure of an estimated $5,217,000.

The mine was nearly filled with water when the testing began, and it will require 1.3 billion cubic feet of gas at 130-psig pressure to hold back the static head of water once the mine has been pumped clear. The first attempt at drilling an injection well at the north, or high, end of the mine was thought to be unsuccessful, but when water and sand were injected under a high pressure, an entrance to the cavern was forced through seams in the rock. A second one bottomed in coal. A third well, of 12-inch diameter and fitted with a $10\frac{3}{4}$-inch-diameter pipe, hit the mine squarely at 700 feet and is serving as the principal test injection well. If the mine is found to be gas-tight, the mine's four shafts will be sealed and the entire cavern will be filled with gas as a final test.

Rock cores taken during the drilling of the first well and other preliminary investigations indicate that the rock strata above and below the coal seam should form a gas-tight seal. It is possible, however, that porosity in the rock may permit gas to escape. If such is the case, silicon tetrachloride gas will be injected into the caverns. This gas has an affinity for water and water vapor, and will build up a deposit of water glass on the grains, gradually plugging the porous sand. In the event the entire mine is found to be gas-tight, development of the space as a storage vault will begin immediately.

★ ★ ★

New High-Pressure Laboratory

A high-pressure laboratory, termed one of the most advanced of its kind and a model of safe construction and convenience, was recently put into operation by Eastman Kodak Company, Rochester, N. Y. The new unit specializes in the production of small quantities of chemicals that cannot be made under ordinary pressure conditions or that would require unusually long reaction times. The 40×100-foot building, of 1-story construction, required 1055 tons of concrete. It contains five safety cubicles, each equipped for two chemical reactors. Three walls of each cubicle are of 20-inch reinforced concrete. The fourth wall, which is

detachable, is of thin plastic, mounted on breakaway pins that will shear off under pressure. Outside the plastic wall is a protective curtain of steel netting, backed by an earthen barrier. Access to each reactor room is possible only by opening a steel door, interlocked to stop stirring and heating operations safely when the door is opened. Chemists view the reactors and their pressure gauges over closed-circuit television. Thus, no pressure or gas lines penetrate the wall between the operator and the reactor.

★ ★ ★

Chameleon Satellite For Space

The idea of changing a man-made satellite's color for the protection of payloads involves the application of a heat-sensitive coating to the skin, thereby controlling internal temperatures while the vehicle is whirling through space. The theory is based on the well-known phenomenon that light colors reflect heat and dark ones absorb it. According to Rudolf X. Meyer of the Physical Research Laboratory at Space Technology Laboratories, Inc., Los Angeles, Calif., with the coating the inside temperature would automatically be kept uniform. As the temperature of the satellite increases, its skin would become light in color, thereby allowing more heat to be reflected into space. Should the payload's internal temperature take a downward turn, the skin would become dark again, thereby absorbing more radiation. Thirty-five substances with the necessary qualities were found, and they vary from paint-like materials to multilayered plastics. In the past, such coatings have been used to indicate temperature—as on wheel bearings of railroad cars to speed inspection—but it is thought that the coverings have never before been used to control heat. Once the process has been perfected for outer space, applications on earth will be studied, and at first glance, these seem to be limitless.

★ ★ ★

Two More Fast Years For Campbell

Donald Campbell has given himself 2 more years of seeking new world speed records before he retires from the exciting but dangerous occupation. In 1958 Campbell set a mark of 248.62 mph in his jet-powered hydroplane, *Bluebird II*. It was his sixth new world's record beyond the so-called "water barrier" (about 200 mph) since he claimed the distinction with a speed of 203.32 mph in 1955. Before he hangs up his crash helmet, Campbell hopes to break his current water record once more, probably in Canada, then set a new world land speed record on Utah's salt flats. Work already has started on a car for this purpose; the fast vehicle must exceed the 394.196 mph set by the late John Cobb of Britain. (Cobb died when his hydroplane disintegrated at slightly more than 200 mph in a 1952 run.) Sheer speed, however, is not the only purpose of Campbell's attempts. *Bluebird II*, for example, was built to test new engineering theories for building and controlling high-speed water craft. Stresses for each frame member were determined after an exhaustive investigation of movies showing Cobb's boat breakup. This information was used in building the tubular steel space frame for the boat—a frame having, in its vertical plane, about twice the stress factor required for a supersonic fighter. The craft was tested successfully to a factor of 27 g's. Such lightweight frames (*Bluebird II*'s 24-foot hull weighs only 580 pounds) are also used in racing cars and were originally built for aircraft. Campbell is the heir to a hunger for speed. His father, Sir Malcolm Campbell, raced against time in conveyances ranging from motorcycles to hydroplanes. He once held both the land and water speed records. His son has adapted the Bluebird name Sir Malcolm used for his cars and boats.

★ ★ ★

Saving Lake Trout

The sea lamprey, which feeds by attaching itself to fish and rasping away flesh with horny teeth, was discovered in Lake Erie in 1920. Increasing numbers of them appeared in Lake Huron during the ensuing decade. During the same interval, the commercial trout catch, which had averaged 3,000,000 pounds annually, dropped to 50,000 pounds in 1946. Clearly the lake trout could be lost as a fish resource in the Great Lakes area, and investigations were begun to find a means of controlling the rapid spread of the lampreys. Mechanical barriers to prevent them from reaching their spawning grounds were effective, but inefficient. Meanwhile, they had spread in great numbers to Lake Michigan and Lake Superior, where the annual trout catch also dropped alarmingly. An electrical barrier was tried, and its effectiveness was heartening. Now a good solution seems to have been found in a chemical that destroys lamprey larvae without affecting other fish. In a test on eleven streams in Lake Superior, only one showed signs of any survival of lamprey larvae.

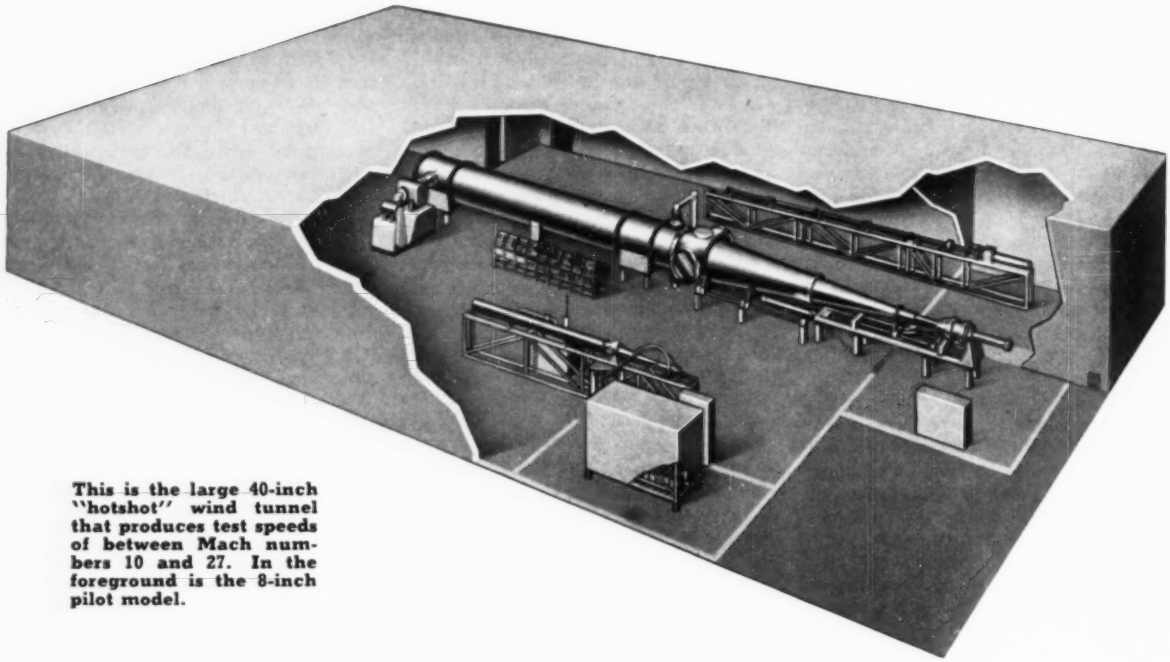
★ ★ ★

Precolored Aluminum Jacketing

Aluminum jacketing with a factory-baked colored enamel finish was used over insulation on practically all process vessels and pipelines in The Superior Oil Company's new Lowry gas processing plant, of the refrigerated absorption type, near Lake Arthur, La. While colored process equipment is being used increasingly by refineries for its eye appeal, in this case, the enameled aluminum was specified for operational reasons as well. The aluminum was coated on both sides during the manufacturing process with the durable enamel. This increases the protection to the jacketing. Even if mechanical damage should occur, aluminum resists most types of corrosion. All painting of the pipes and vessels on the site was eliminated. Since some 25,000 pounds of the Reynolds Colorweld, in 0.016- and 0.024-inch gauge, were used on the Superior job, it is estimated that the application was more economical than installation of any unpainted type of metal jacketing with its subsequent, necessary painting on the site.

Filled Like Footballs

Use of sidewall-inflated tubeless aircraft tires, that eliminate valve stems and provide greater design flexibility, is becoming widespread on both military and commercial aircraft. Advantages include an improved wheel and brake design and the possibility of mounting dual tires on single wheels without sacrificing safety of individual inflation. Having withstood crush tests to 35 tons at inflation pressures of as much as 385 psig, as well as extreme temperature variations, the tires have qualified for both the U. S. Air Force and the Navy, according to reports received from The Goodyear Tire & Rubber Company. They are also being installed as standard equipment on most Cessna and Beech aircraft. The tires are inflated by inserting a standard inflation needle in the sidewall. The valve itself is approximately 0.6 inch in diameter and is inserted in the tire flush to the sidewall.



This is the large 40-inch "hotshot" wind tunnel that produces test speeds of between Mach numbers 10 and 27. In the foreground is the 8-inch pilot model.

"Hotshot" Tunnel—

For Speeds To Mach 27

BOEING Airplane Company is completing a 40-inch diameter wind tunnel whose "winds," if ever found in nature, would be terrifying for the facility is designed to attain air speeds up to Mach 27. The tunnel's minimum testing speed is Mach 10. It is second in size and energy capacity only to the government establishment at Arnold Engineering Development Center, Tullahoma, Tenn. (see COMPRESSED AIR MAGAZINE, March 1957).

Technically the installation is described as an electric-arc-discharge type, commonly called a "hotshot" tunnel. A highly charged arc of electricity triggers each test. The electricity is stored in a bank of 2280 capacitors within the wind tunnel building. Weighing 165 tons, this bank has a power of 7,000,000 watt-seconds, charged at 6000 v from a rectifier circuit.

Other components in the 65-foot-long tunnel include an arc discharge chamber for holding high-pressure, high-temperature air; a unique tungsten throat; a test section where the model is mounted; and a vacuum system to lower the pressure in the tunnel to nearly zero.

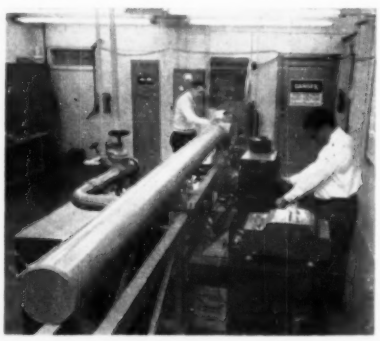
Before a test run, the condenser bank is charged, air up to 2000-psig pressure is forced at room temperature into the arc chamber, and the tunnel is evacuated. The test begins when a circuit is completed between a small trigger electrode and one of two large arc electrodes in the chamber. The 0.004-inch steel wire connecting the small and large electrode vaporizes and establishes a local field of ionized air. This plasma allows the capacitor bank to discharge and produce an arc between the two main electrodes. The high-energy arc creates a high temperature and pressure plasma in the chamber and a plastic diaphragm, separating the arc chamber and the tunnel, bursts. The resulting shock wave of high-pressure air rushes through the nozzle into the test section and flows over the model. Arc-chamber pressures can be varied from 4000 to 30,000 psig, and the flow of air through the test area may take the relatively long period of $\frac{1}{25}$ of a second. The volume in the arc chamber can be varied mechanically from 160 to 640 cubic inches.

With a general appearance much like a bushing, the tungsten nozzle has a very small opening (at Mach 27 only 0.024 inch in diameter). There is a conical expansion region on the test-section end. Even with tungsten's high melting temperature and resistance to thermal shock, the 5000° to 25,000° F of the onrushing arc-chamber air takes its toll. Each nozzle can be used for only about two runs and must be calibrated after each because of the metal that is worn away.

The Boeing Tunnel's altitude minimums include testing for 180,000 feet at Mach 10 and 150,000 feet at Mach 20. Altitudes above these can be readily simulated. During the period when a model is subjected to the high-speed air, information is collected on 50 channels and oscillograph recorders transfer this data to paper at a rate up to 160 inches per second.

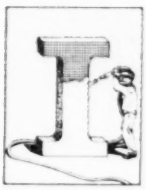
YOUNGER BROTHER

An 8-inch pilot model "hotshot" wind tunnel that helped Boeing personnel design the larger version. The company has fourteen tunnels of various types.



EDITORIAL

Gunite



IDEALLY speaking, the universal construction material should be one that is readily available anywhere, inexpensive, easily transportable, plastic for easy formability in the field and structurally sound once in place. It goes without saying that engineers have been searching for such a material for centuries and that it hasn't as yet been found. One that does come quite close, although by no means can it be called the universal material, is pneumatically placed concrete or Gunite.

Gunite is a trade name designating a proportioned mixture of Portland cement and sand which is pneumatically conveyed in a dry state to a nozzle. There, hydration of the cement takes place immediately prior to ejection. The terms "pneumatically placed mortar" or "pneumatically placed concrete" are perhaps more accurate descriptions than Gunite but, as is common, the shorter term has found almost universal favor. Strictly speaking, Gunite is the trade name of the Cement Gun Company, Allentown, Pa., and has belonged to that firm since it introduced the process in the early 1900's.

FROM the standpoint of application, Gunite might almost be called a universal material for it has been utilized for practically every type of building work. It is equally good for lining reservoirs and in thin shell dome roofs. Complete new buildings can be formed of it or old, badly weathered and spalled masonry buildings can be completely renovated, both inside and out. It is often used to line hard-rock tunnels, yet cut-and-cover pipes and tunnels have been formed in place with the material. Regular-shaped buildings are made with it, however one of its major advantages is its ability to form any type of irregular surface.

In the years since its introduction, pneumatically placed concrete has been substantially improved. Essentially the method remains identical to early days in the field, however a great deal more is known today about proper mixtures to achieve desired compressive strengths; the adequate use of reinforcing steel and mesh; correct angle and distance of the nozzle in relation to the work; required pressures, both of air and water, for varying lengths of delivery hoses; etc.

A great deal of the current information as well as standard specifications for high-quality pneumatically placed concrete come from the Gunite Contractors Association. Formed in 1952 and headquartered in Los Angeles, Calif., the group has done much to advance the quality and promote the usefulness of Gunite. It also seeks the modification of many specification-type building codes to permit the use of the material. (Such codes, according to many builder's groups, result in high costs in a great many cases and should be altered to performance standards to take advantage of new or improved methods and materials.)

COMPRESSED air, of course, is the key to Guniting. The Gunite Contractors Association has established a minimum volume of 365 cfm of free air for satisfactory work. A pressure of 45 psig is needed in the chamber of the cement gun when a hose not more than 100 feet in length is required for delivery of the material to the nozzle. The chamber pressure, the Association specifies, should then be increased in increments of 5 psig for each additional 50-foot length of hose.

Air is not only used in the Gunite process for conveying the material from the chamber to the nozzle but powers air motors doing a variety of other jobs. In many cases one is utilized in combining the dry mix. In others, an air motor drives an agitator within the chamber so that material will flow easily into the hoses. In addition, water must be supplied to the nozzle at a pressure at least 15 psig above the air pressure. There are few sources of water at that pressure available to the average Gunite contractor, therefore air-motor driven pumps are utilized.

INDEED the requirements for compressed air for Guniting work are so numerous that, practically speaking, the industry's standard machine is a 600-cfm unit of the rotary type. This enables the contractor to supply his gun with a full 365 cfm and still have sufficient air to run accessory equipment. Many contractors credit the introduction of the rotary vane-type 600-cfm portable compressor in 1950 with giving "a tremendous shot in the arm to Guniting work." The 500-cfm reciprocating units available prior to that time, they say, were not of great enough capacity for best efficiency. It was at times necessary to utilize two 315-cfm compressors to attain satisfactory results. Besides delivering far more air, rotaries are considerably lighter in weight, making them more adaptable to a wide range of Guniting jobs. They also deliver air at a more uniform pressure than do reciprocating units — the pressure range required for efficient regulation is not as wide in rotary units. This so-called "maintained" air pressure results in Gunite of a more uniform density and thus of a higher quality. It also reduces costs by eliminating excessive rebound and the consequent wastage that occurs at the high-pressure "end" of the regulation range.

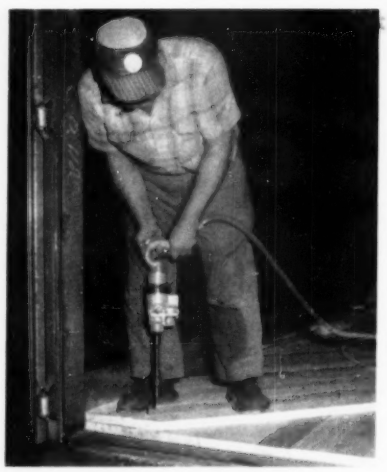
From an air industry viewpoint, we look on Guniting as another process that not only relies on compressed air for its success, but looks to advances in air power to lead its own steps forward.

Application: Driving Screws

A STEEL products concern in southern U. S. was having problems driving quarter-inch screws through the hardwood flooring and metal crosspieces that formed the beds of large tractor-trailers. First attempts at driving the screws with air impact wrenches were found to be too slow. Although air-operated wrenches are ideal for many jobs, this was not one of them.

After attempts at using a larger impact wrench also proved impractical, it was decided that an air drill was better for the application. The manufacturer obtained an Ingersoll-Rand Size 2M drill fitted with a threaded spindle, a socket adapter and a quick-change chuck. The drill did an excellent job of quickly driving the 2-inch-long screws to positively draw the wood boards tightly to the steel floor beams. Further, the same tool can be used as a drill motor. The company obtained two of the drills and put them into use.

The air tool is well suited to the task. Maintenance has been negligible. The use of the Ingersoll-Rand straight torque screw driver reduced screw driver bit breakage to a small fraction of its former cost.

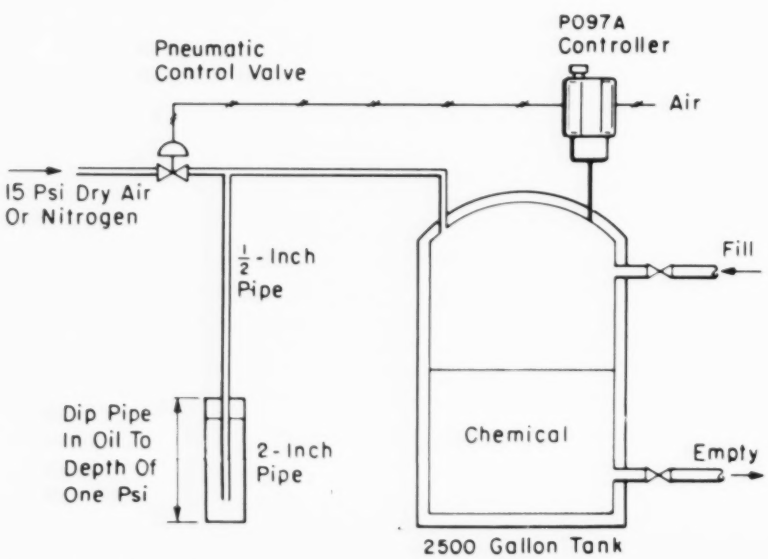


DRILL DRIVES SCREWS

This operator uses an Ingersoll-Rand air-powered 2M drill to drive 2-inch-long screws into the wood flooring of this tractor-trailer. The $\frac{1}{4}$-inch diameter screws also must pass through metal crosspieces.

Application: Controlling Tank Atmosphere

A 2500-gallon tank for outside storage of chemicals posed a problem for the Trubek Laboratories, East Rutherford, N. J. If the chemical inside the tank became wet, corrosive acids would form—but the tank still needed an internal gas atmosphere that could "breathe."



Photo, Industrial Control News

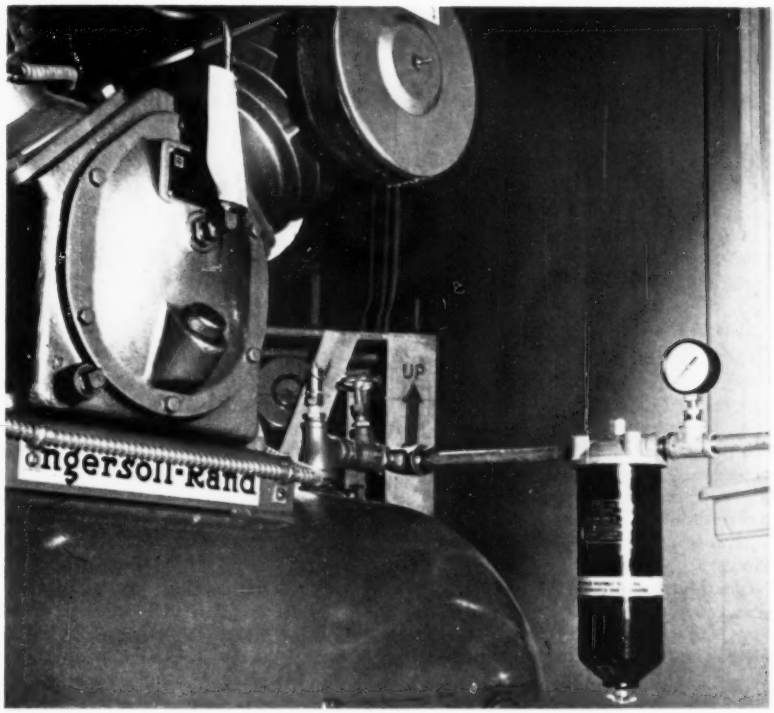
The company installed a system that automatically feeds dry air (or nitrogen when an inert atmosphere is needed) into the large container as the chemical contents are withdrawn, or when a temperature drop causes contraction of the tank's contents. When more chemical is pumped into the tank, or when expansion occurs, the same system exhausts air or gas through a pipe outlet immersed in oil.

At the left is a diagram that shows the plan of the system. A Minneapolis-Honeywell pneumatic proportional pressure controller (model P097A) above the tank is set at $\frac{1}{2}$ psig. This is connected to the tank and to a pneumatic valve mounted in the 15-psig dry air (or inert gas) supply line. When air pressure drops inside the tank, the pressure controller senses the change and causes the valve to admit air. When air pressure rises in the tank, the valve is closed and the excess gas bubbles out through the oil-immersed outlet.

Such an arrangement is simple and economical. While preventing rain or other moisture from entering, it maintains a constant gas pressure in the tank regardless of the level of the chemical inside or the air temperature outside.

Separation, not absorption, is principle behind—

NEW AIR LINE FILTER



VIRTUALLY every manufacturing and maintenance facility uses compressed air for numerous applications. Almost without exception, this air must be clean as free as possible from all contaminants, oil and moisture that would be damaging to pneumatic equipment. To satisfy this requirement, a wide variety of filters is marketed. Fram Corporation, maker of gasoline, oil, water and air filters, and replacement cartridges, has devised a compressed air filter that removes entrained airline contaminants by a separation process rather than absorption. Following thorough field testing, the company believes its unit to be superior, and states that it does the job without excessive line-pressure drop.

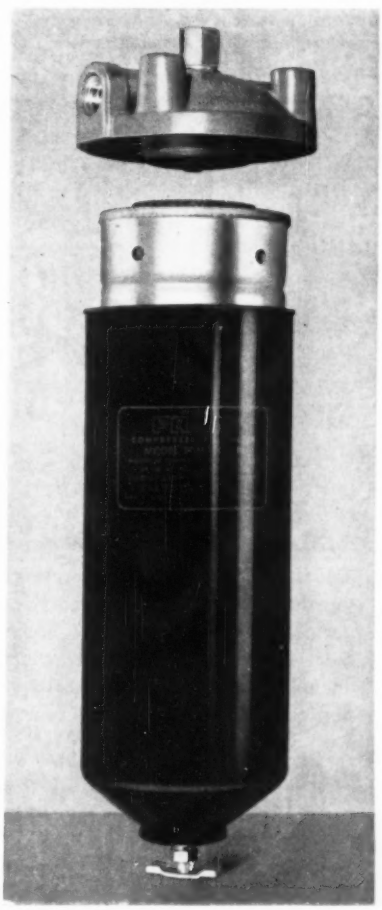
The unit, designated as Model FBM 1900-PL, is $11\frac{3}{4}$ inches high and has body and head sizes of $3\frac{1}{2}$ and 4 inches O.D., respectively. The body is fabricated of heavy-gauge, rust-resistant drawn steel; the filter head is of cast aluminum and fitted for $\frac{3}{8}$-inch 18-NTP inlet and outlet connections. It is easily installed at any point in an air line, but should be as close as possible to the equipment being protected to pick up all of the rust, scale, moisture, and the like in the air line.

The new Fram unit will operate to pressures of 125 psig, making it satisfactory for shop air lines operating at a nominal pressure of 100 psig. It has a rated free-air flow of 20 scfm and a very low initial pressure drop when removing both solid particles and great quantities of liquid.

As water and oil accumulate, they can be drained periodically through a cock located at the bottom of the filter body (see illustrations). Depending on the service, this may be done as infrequently as once a week. Because of the filter's high efficiency, the manufacturer recommends that under average conditions the unit be drained daily, and at times, even more frequently.

The filter cartridge, which retains any solid particles in the air flow, is also easily serviced. The cartridge contains a specially treated pleated paper media that has been specifically designed for this application. It contains a corrugated center tube. Both end caps are of hard paper that has been treated with a resin, and they are fitted with cork gaskets. The Fram filter is shown (right), its aluminum head raised. The cartridge container can be seen protruding from the body, and the gasket area is readily visible.

To change the filter media, the air supply valve is closed. Then a filter cap screw is loosened with a wrench until the filter body and cartridge can be easily drawn down and away from the cap, and separated. After wiping the inside of the body clean, a new cartridge is ready to be installed in the filter body, which is then re-attached to the cap. When the air valve is re-opened, the filter is again operational. The other illustration shows an installation with an Ingersoll-Rand receiver-mounted Type 30 compressor. The shut-off valve is located atop the receiver (downstream from a safety valve). This is followed by the Fram filter and, on the discharge side of the line, a pressure gauge.



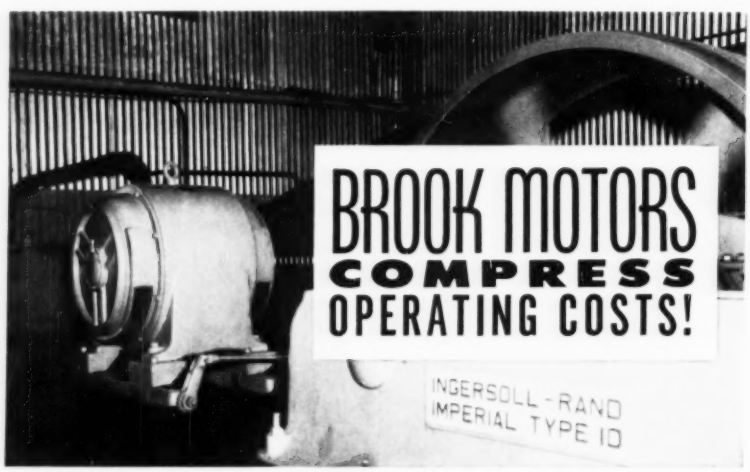
Industrial Notes

SMALL "packaged" air compressors for automotive or industrial applications, can be selected with the guidance of *Compressed Air Fundamentals*. This compact flier contains many essential facts for compressed air users, but basically describes compressed air, how it is compressed, single- and 2-stage compressors, piston displacement, actual delivery, unloading of compressors, regulation, and types of control used. Data about compressor oils, pipe and wire sizes, and terminology and definitions used in connection with the compression of air are also included. Tabular and chart information about the cubic feet of air required to operate a variety of pneumatic equipment, average and continuous air supply tables, cylinder diameters required to develop power to overcome indicated loads, volumes of compressed air needed per stroke to operate various-sized air cylinders, a chart of ratios of compression, and tables of air flow through orifices complete the publication. A good source of information, Form 1548 is free of charge. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

REFRIGIFILTER is a new refrigerated unit designed to safeguard pneumatically operated equipment from moisture, oil and contaminants. Especially intended for locations where cooling water is unavailable or where the ambient temperature varies a great deal, Refrigifilter lowers the dew point of compressed air to approximately 35° F at pressure. It thus condenses more than 90 percent of moisture and oil vapors and at the same time removes all entrained liquids. (If allowed to remain in compressed air lines, these fouling elements can cause instrument and control malfunction and result in costly equipment down time.) By eliminating these elements the Refrigifilter reportedly assures the delivery of clean, moisture- and oil-free air to all pneumatic control elements. The unit is rated at 100 scfm at 100 psig and 100° F. It combines a heat-exchanger, evaporator, refrigerating section and filter element into one. *Hankison Corporation*, College & Pike, Canonsburg, Pa.

A LINE of 4- and 5-port stainless steel plug valves, suited for a wide range of services, have Teflon sleeves that require no lubrication. The Tufline valves reportedly operate in any position without seizing. They are available in the 150-pound class from $\frac{1}{2}$- through

2-inch sizes in both flanged and screw ends. Because of their multiport design and nonlubricating features, users save in the number of valves needed and maintenance cost. The units are compact and sturdy and have a ribbed internal construction to lock the sleeve in position, while at the same time allowing for its expansion and contraction without leakage. Their fully enclosed metal construction, unexposed Teflon, and 4-bolted covers provide protection



Users report savings on operating costs when BROOK A.C. MOTORS furnish power for compressors, pumps, conveyors and machinery in factories, mills and mines. Brook Motors require less maintenance. There is no finer motor built, yet they *cost less*. All standard enclosures, including NEMA Rerates. 1 to 600 H. P. Warehouse stocks, factory representatives and dealers coast-to-coast. Send for literature.

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BROOK MOTOR CORPORATION

world's most respected motor

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In Canada: Brook Electric Motors of Canada, Ltd.
250 University Ave., Toronto, Ontario

"Never lost a man yet—several sissies, perhaps, but no men."

against fire or line shock. Absence of lubrication prevents steam contamination, and the sleeve wiping action keeps the plug free of adhering solids and liquids. The valves handle media from light gases and solvents to heavy slurries and corrosive liquids. They provide trouble-free service, it is said, through a temperature range of minus 150° to plus 400° F and a pressure range from high vacuum to 275 psig. *Continental Manufacturing Company*, 247 Park Avenue, New York 17, N. Y.

BRONZE and iron gate, globe and check valves for heating, piping and air conditioning systems are illustrated and described in circular V-6. Essentially a condensed catalog, the publication includes descriptions of valves with pressure ratings from 125 through 300 psig. Each provides applications, basic design features and standard sizes. In addition to the conventional screwed and flanged end valves, threadless units for soldered or silver-brazed connections, and Underwriters approved valves are shown. *Fairbanks Company*, 393 Lafayette Street, New York 3, N. Y.

WIRE sizes up to 12 gauge can be severed with an air-operated wire cutter called the Bantam Air-Snip, designed for production-line use in industry. The device is said to be much faster than manual cutters, and eliminates the hand motions necessary with manual types. It therefore increases operator output

and reduces fatigue. The cutter has an over-all length of 9 inches, a width of 3 inches and a height of 4½ inches. Its shipping weight is 7 pounds and it comes complete with solenoid air valve and electric foot switch. *Air Fixtures, Inc.*, 225 E. Main Street, North Manchester, Ind.

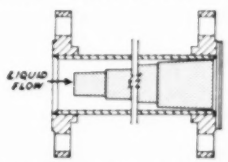
NINE basic filter element materials for a wide variety of air, gas and liquid filtering requirements are described in a 4-page, 2-color catalog, No. BFD-48. The nine materials are called Micropleat, Microedge, Microbon, Microfil, Microlox, Micromesh, Microglass, Poromesh and Poroloy. These use various filter materials including impregnated cellulose, bonded inorganic fiber, powdered nonferrous materials, woven metal mesh and treated glass fiber. Applications for the materials include filtering for air compressors and air lines, as well as dozens of other uses ranging from food processing to missile ground test and support equipment. *Bendix Filter Division*, Bendix Aviation Corporation, 434 W. Twelve-Mile Road, Madison Heights, Mich.

A SELF-CONTAINED spray gun that can be held easily in one hand can be used anywhere in the field, even if a compressor is not available. Known as the Sprayon Jet-Pak, it requires no hoses or electric wires. It is powered by a replaceable can of propellant gas that delivers a steady constant pressure. Its portability and low cost make it practical for production and maintenance jobs where spraying gives the best results. The manufacturer states that any liquid that can be thinned to the proper consistancy can be applied with the unit, including lacquers, stains, enamels and latex paint. It also handles

NEW PIPING STRAINERS

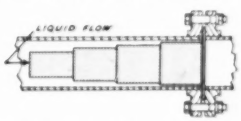
Simplify removal of objectionable dirt from any piping system

Elimination of objectionable dirt particles and other foreign matter from air, gas or liquid streams is accomplished effectively with Air-Maze Piping Strainers.



Installation of Air-Maze Piping Strainer in pipe strainer body.

For economy of installation, these strainers are mounted directly into any line using conventional Schedule 40 S pipe and Series 15 flanges. Cylindrical in design, the metal media has multiple steps to provide maximum filtration area. Media in opening sizes .0013" to .0307" can be supplied. Maximum operating temperature 250°F. Maximum pressure drop 50 psi.



Installation of Air-Maze Piping Strainer in flange pipe.

Furnished with pipe strainer bodies, where required for nominal pipe sizes from 2" to 24". Write Air-Maze Corporation, Department CA-10, Cleveland 28, Ohio. (Subsidiary of ROCKWELL-STANDARD Corporation)

AIR-MAZE

The Filter Engineers

AIR FILTERS • SILENCERS • SPARK ARRESTERS • LIQUID FILTERS
OIL SEPARATORS • GREASE FILTERS

NEW IR EJECTORS

Cut Vacuum Costs

New Series M Steam Jet Ejectors, with rugged, two-piece construction, offer big savings for general vacuum service

FOR CREATING vacuums, there is nothing simpler or more reliable than the new Ingersoll-Rand Series M ejectors. Designed to operate with 75 to 200 psig steam, they can handle either dry or wet gases and can be used for priming pumps and other hydraulic equipment. The low-cost Series M line includes 1½", 2" and 3" sizes with threaded connections and 4" size with flanged suction and discharge. For full details, send for new Bulletin No. 9046.

Ingersoll-Rand

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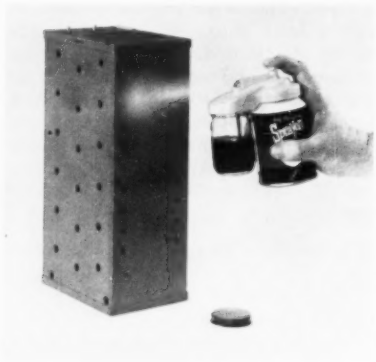
lubricants, protective coatings and special solutions—everything from antirust compounds to solvents and adhesives. Jet-Pak is ideal for touch-up of finish both on the job and in maintenance of equipment. Extra jars are available,

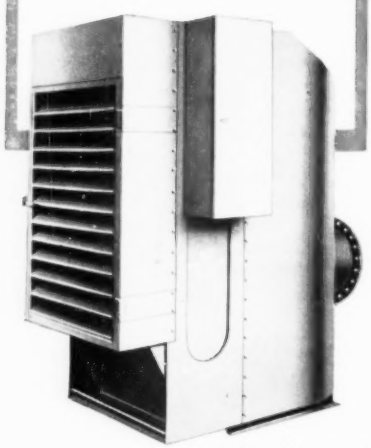


allowing the user to keep a number of different liquids ready for quick spraying with a single spray unit. *Sprayon Products, Inc.*, 2075 E. Sixty-fifth Street, Cleveland 3, Ohio.

CONDENSIFILTERS that incorporate an internal trap are featured in 4-page Product Bulletin No. 4158. A combination condenser, separator and filter responsible for removing both entrained and vaporized moisture and oil from compressed air lines, the Condensifilters have Mag-Pneu-Power traps installed as optional items. Descriptions, specifications and cross-sectional line drawings of Model M-30T and Model M-100T are given. Models M-30 and M-100 without the internal trap are also available if desired. *Hankison Corporation*, College and Pike, Canonsburg, Pa.

POLYETHYLENE tube packs encased in vinyl for use as air carriers in automation equipment have been developed by Pyramid Plastics, Inc. The jacket is an extrusion of abrasion-resistant Geon vinyl compound, a product of B. F. Goodrich Chemical Company. It protects the interior tubes—from 2 to 37 color-coded, small-diameter, air pressure lines—from external damage and aids in the installation of a system. Many chemical processing plants, refineries and other automated industries conduct remote control systems from a central point. Air lines run from control panels through meters and gauges to valves and other operating devices. The air lines are the nerve network of the plant. The tube packs will assure that they remain clean and safe, and in continuous, dependable operation. Further information may be obtained by writing to the vinyl manu-

AAF Multi-Duty Filters Assure Clean Intake Air Automatically



Type CMS Multi-Duty for air volumes of 3000 CFM and up.

When your engines and compressors are protected by AAF Multi-Duty Self-Cleaning Filters, you *know* that intake air is *clean.*

Uniform air delivery, constant efficiency, low operating resistance and infrequent maintenance are "musts" for true dust protection. Multi-Duty measures up on every count because this filter keeps itself "fit" through continuous self-cleaning action.

Would you like more information? Write today for our 16 page illustrated catalog.

AAF — herman nelson

American Air Filter

COMPANY, INC.

402 Central Avenue, Louisville 8, Kentucky

American Air Filter of Canada, Ltd., Montreal, P. Q.

facturer. *B. F. Goodrich Chemical Company*, 3135 Euclid Avenue, Cleveland 15, Ohio.

INDUSTRIAL GASES, their production and commercial applications, are thoroughly discussed in Catalog ADC 892 published by Air Reduction. Illustrated with both 4-color and black-and-white photographs and drawings, the 32-page booklet offers a comprehensive survey of how each gas is made, delivered and used. Emphasis is placed on the extensive use of each in metal working, chemistry, building and construction applications, aircraft and missile work, food processing, electronics and steel production. Oxygen, nitrogen, argon, helium, acetylene, hydrogen, carbon dioxide and the rare gases are described. Copies of the publication are available from the manufacturer without charge. *Air Reduction Sales Company*, Air Reduction Company, Inc., 150 E. Forty-second Street, New York 17, N. Y.

ENGINEERING data, design relationships and standard size data of Bellofram seals are contained in a comprehensive manual, No. BF 200-3. The 20-page catalog presents a basic description of the units, applications and uses, as well as typical installation drawings, methods of attachment, installation techniques and standard dimensions. A detailed analysis of four basic classes of seals is included. Construction materials of standard elastomer compounds and standard and nonstandard fabrics are tabulated. Tables list tolerances for all classes of the seals. Another section illustrates the applications of the units in such devices as

"Relax, Fred, I'll only be a minute."

NUGENT

FILTERS • STRAINERS
LUBRICATION SPECIALTIES

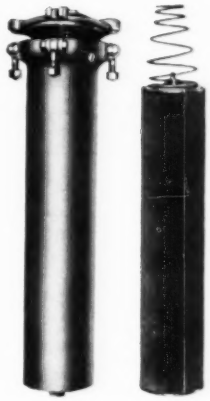


Fig. 1555BF Duplex Filter uses factory packaged laminated fiber disc filtering elements. Each filter comprising duplex operates independently or in parallel. Wide range of sizes.

Fig. 1576 Bag-Type Pressure Filters feature inexpensive, completely disposable filter cartridges. For filtering fuel oil, lubricating oil and wide variety of fluids.

AT LEFT: Fig. 1555-4L Filter and laminated disc cartridge. High flow rate; low pressure drop. Excellent micronic efficiency. Cartridges interchangeable with all other Nugent Bag or Depth Type cartridges.

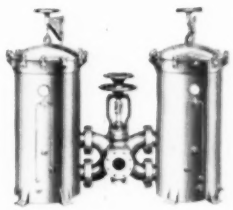


Fig. 1554AN-4L7 Duplex Strainers provide the advantage of uninterrupted flow, without by-passing, while cleaning the strainer baskets. Each strainer comprising duplex uses 7 strainer baskets Fig. 1554A-4L.

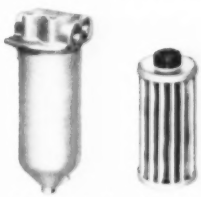


Fig. 1490AM-0 star-shaped extended area strainers offer increased free screen area over round basket type.

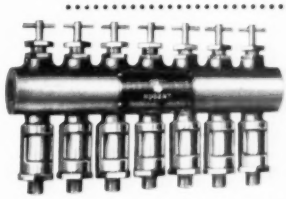


Fig. 1503F Multiple Pressure Oilers are available with from 2 to 24 feeds.

Fig. 524 Sight Feed Valves with removable glass. ¼" to ¾" IPS.

Fig. 1575 Pressure Sight Flow Lubricator. Single units or multiples to 15.

Fig. 1366E Sight Flow Fittings for indicating flow of liquid in a pipe line. Available in brass, cast iron, steel or stainless steel.

Valuable equipment deserves the best possible protection that can be provided. Nugent offers a complete line of filters, strainers and lubrication specialties for this purpose. All are backed by the experience and know-how gained through solving industry's problems in this field for more than 60 years. For bulletins giving complete information on any or all Nugent products, call or write today.

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OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

AUTOMATION!

ARE YOU PLANNING REMOTE OPERATION OF YOUR ENGINES?

McCORD

HAS A COMPLETE LINE OF CONTROLS FOR

McCord Force Feed LUBRICATORS

VISUAL FLOW FILL CONTROL

Operates from central supply tank or engine crankcase.

Install in space of one lubricator feed. No machining or alterations necessary. Large sight feed shows make-up oil when called for by lubricator. Order part No. A31252.

LUB-SENTRY

Install in one pump space. Provision for pressure switch to shut down engine or sound alarm.

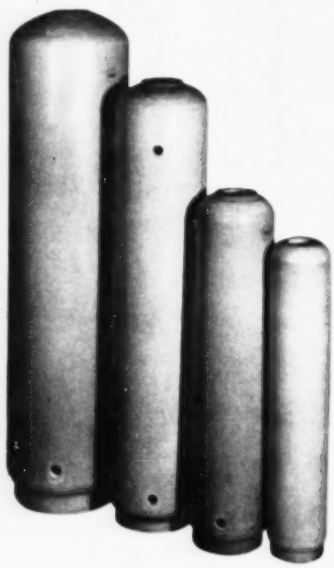
SIGNALS LOW OIL LEVEL OR MECHANICAL FAILURE

Contact your nearest McCord representative or write for catalog sheet McCord Lubricator Controls.

McCORD CORPORATION
LUBRICATOR DIVISION
DETROIT 11, MICH.

regulating valves, pressure switches, remote positioners, balanced valves, fluid barriers, dampers, snubbers and the like. *Bellofram Corporation*, Blanchard Road, Burlington, Mass.

SEAMLESS, reinforced plastic tanks are available in four sizes for containing a wide variety of gases, chemicals and liquids. The units are rated for pressures to 500 psig and production samples are said to have withstood pressure variations from 0 to 150 psig for more than 250,000 cycles. The sizes available are 6-inch diameter by 32 inches in



height, 8×36 inches, 10×48 inches and 13×54 inches. The four weigh, 5, 10, 16, and 33 pounds, only 30 to 50 percent of comparable metal tanks. These plastic containers will not dent or rupture under shock and will not corrode or become contaminated. *Structural Fibers, Inc.*, Department 11, Fifth Avenue, Chardon, Ohio.

COMPRESSOR inlet and outlet pressures are measured and their ratio simultaneously calculated by a pneumatic pressure ratio computer. Features of the unit are said to be its wide range, flexibility, accuracy and pneumatic signal transmission. The instrument indicates pressure ratio on an integral scale and generates a proportional pneumatic signal for use in a control system. Model PR-0, as it is called, can be used in any application that requires calculation of the ratio of two pressures. Under normal operating conditions, ratios of 1-to-5 can be measured throughout a pressure turn down range of 20-to-1. Measured ratios may be

ADAMS FACT FILE #2

PLANT AIR

Moisture Chief Cause of Trouble . . .

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture . . . tool efficiency will be seriously affected.

Some of the Other Problems Created By Wet Compressed Air . . .

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Waterhammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work . . . represent a sizeable power loss.

You Can Lick Compressed Air Moisture Problem . . .

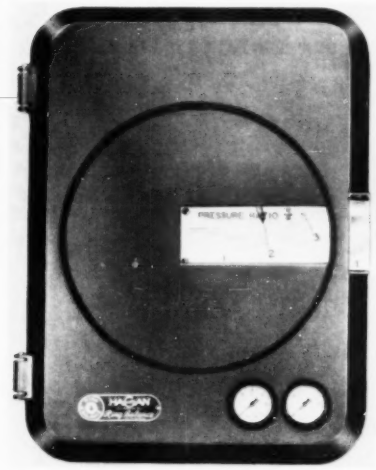
All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

Air Filter for Final Protection at Point of Use . . .

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

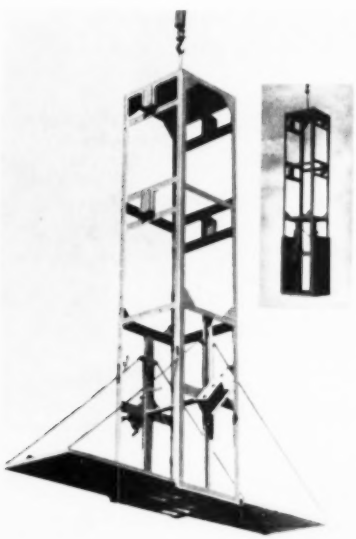
For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 209 East Park Drive, Buffalo 17, New York.

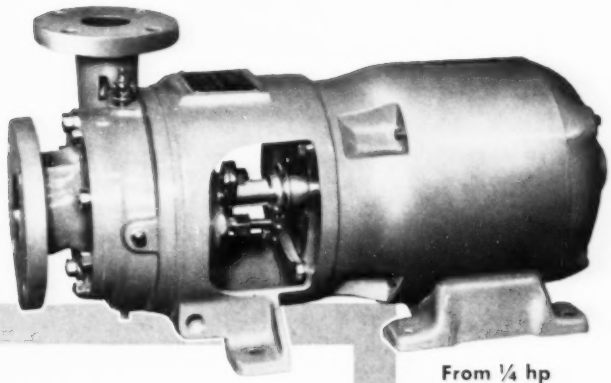
increased as the ratio of maximum pressure values increases. Output signals, in the ranges of 3 to 15 psig and 0 to 30 psig, may be used for recording or indi-



cating instruments or for actuating elements of an automatic control system. *Hagan Chemicals & Controls, Inc.*, Controls Division, P. O. Box 1346, Pittsburgh 30, Pa.

A CAGE designed for transporting a full set of timber down a shaft has provisions for converting the timber skip into a staging when in position. The complete shaft set, whether steel or wood, is loaded on the skip which has wall plates hung vertically on each side. The Lance Timber Cage, doors folded, is lowered to the desired working level. The doors are then placed in a horizontal position to provide a work staging. Wall plates are swung into position and from the confines of the cage (now serv-





From ¼ hp to 75 hp

ready now to solve your pumping problems

Ingersoll-Rand MOTORPUMP

WHEN YOUR IMPORTANT PRODUCTION depends on proven pumping power, you need the efficiency and reliability of I-R Motorpumps! Low maintenance and minimum down-time mean cost-cutting operation that continues to pay off year after year.

I-R Motorpumps are always available in the widest range of types and sizes for every type of installation. Capacities from 5 to 2800 gallons per minute; heads to 650 feet.

Compact Motorpumps are easy to install. They operate in any position, save valuable floor space. Write today for specifications and performance data.

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Yellow Cover
Black Spiral Stripe

"HARDROK" Wire Braid AIR HOSE is being more and more widely used as its reputation for unequalled performance grows. You'll find it coupled to drills, jumbos and other heavy-duty air equipment on the toughest, roughest jobs. There's no mistaking its yellow cover with black spiral stripe . . . sure sign of longer service life and lower hose costs.

"Hardrok" specifications include oilproof Synplastic® tube; horizontally braided steel wire carcass; tough, wear-resistant rubber cover; ½" to 3" sizes; maximum lengths of 50 feet.

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BRANCHES AND DISTRIBUTORS THROUGHOUT THE UNITED STATES.
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ing as a staging and timber storage area) two men can position shaft sets or timber in a minimum of working time. After completing the set, the doors are raised and the cage is pulled from the shaft, ready to be loaded for the next set. *Machinery Center, Inc.*, P. O. Box 964, Salt Lake City 10, Utah.

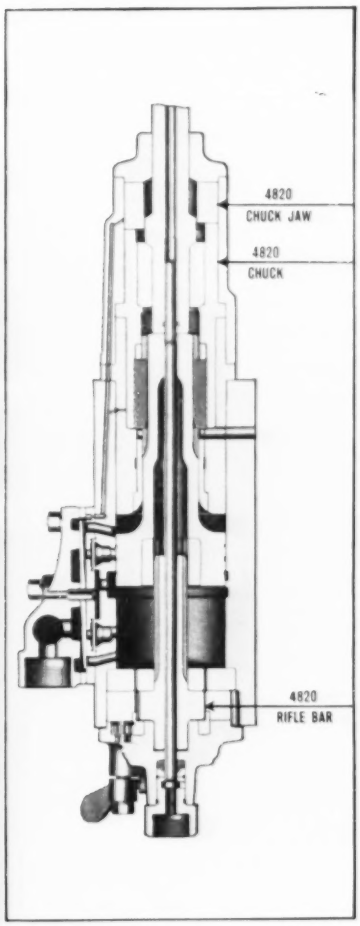
TWO ALTERNATE bases, offering great piping versatility, are available for Hannifin's Series CC 4-way directional air control valves. The Universal base is normally used when combination piping and gasket mounting is desired.

Universal Base

Gasket Mounted Base

All eight ports are tapped for ¼- or ⅜-inch pipe, and the bottom ports are also O-ring grooved for gasket mounting. When only gasket mounting is required, the Gasket Mounted base is recommended. In this, bottom ports are O-ring grooved for mounting directly to the manifold or pad of a machine. *Hannifin Company*, Department 156, 501 S. Wolf Road, Des Plaines, Ill.

"Make it fast, young fellow, this is a busy plant."



Self-propelled blast hole drill in operation on a road construction job. Drill is a 4½" bore heavy duty unit; uses Type 4820 nickel alloy steel parts. Product of Ingersoll-Rand Corp., 11 Broadway, New York 4, N. Y.

New self-propelled blast hole drill uses nickel steel parts for high power capacity

...Type 4820 nickel steel provides high strength plus wear resistance

To insure rugged dependability in its versatile new Crawl-ir self-propelled blast hole drill, Ingersoll-Rand puts high-performance nickel-molybdenum alloy steel – type 4820 – into stressed drill head parts. (See cutaway drawing.) To give you a brief idea of its properties ...

Type 4820 nickel alloy carburizing steel (0.19% C, oil quenched) averages 195,000 psi tensile, 160,000 psi yield strengths, with high Brinell surface hardness. Case and core properties can be closely controlled by selecting rates and temperatures of box cooling, reheating, quenching and drawing.

Nickel steel parts contribute mightily to this drill's dependability – provide the combination of wear resistance, impact and tensile strengths needed for long service. This steel is freely available from steel producers and service centers across the country.

Latest information on Type 4820 and other nickel steels, as applied to your specific metal problems, is yours by writing Inco.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street, New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

Honest, Johnny... that's a real truck!

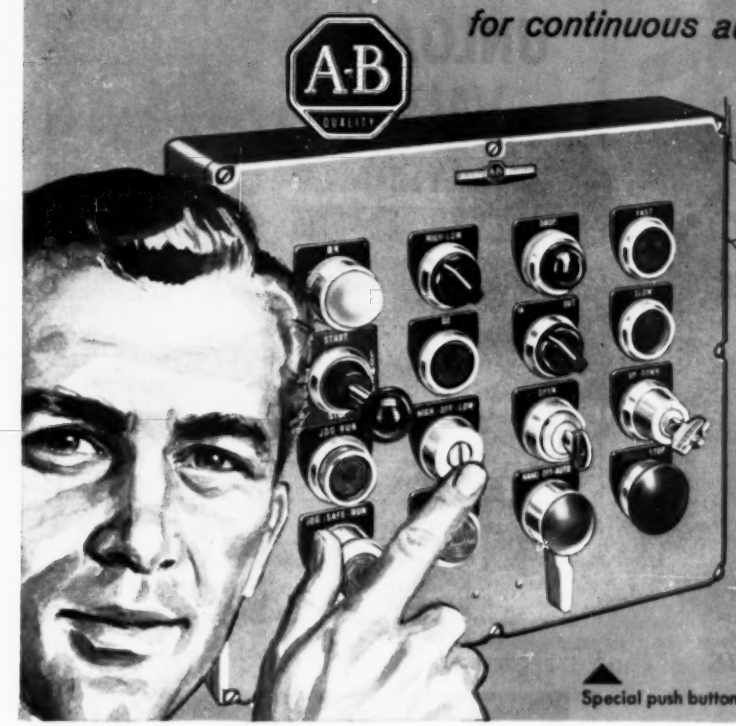
Johnny's confused! This Bucyrus-Erie excavator makes the truck look like a toy. But the fact that the Bucyrus machine towers over other equipment is not really important to its owners. What they like are its towering production records. Just think, in 24 hours it can remove over 120,000 tons of overburden!

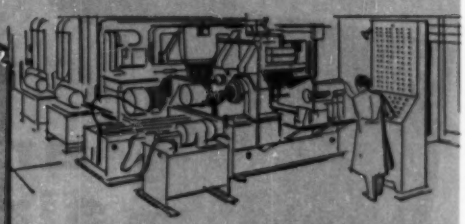
Now is the time to take a fresh look at *your* operation and equipment. It is certain that somewhere in the B-E line there is an excavator that will fit your exact needs. Bucyrus-Erie builds shovels from $\frac{3}{8}$ yards on up through 65 cubic yards. And, through the entire line, Bucyrus-Erie machines are GIANTS when it comes to production.

BUCYRUS
ERIE

AUTOMATION BEGINS HERE

... Insist on Allen-Bradley accessories for continuous automatic production

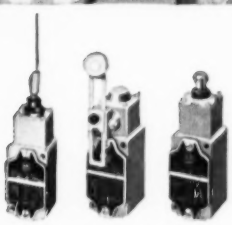




In this broad line of Allen-Bradley accessories, each and every unit carries the traditional A-B trademark of *quality* that stands for trouble free operation. Rugged construction, and maintenance free, silver alloy contacts provide the reliability that is essential to the continuous operation of *your* automatic production machines.

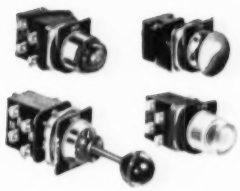
Profit from the experience of the leading machine tool builders . . . insist on Allen-Bradley *quality* motor control *all the way!*

Special push button panels can be assembled to your specifications.

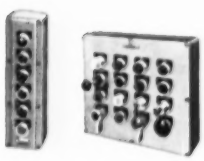


OILTIGHT LIMIT SWITCH
Bulletin 802T with sealed heads and bodies. Various operators.

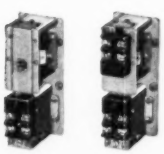
PRECISION LIMIT SWITCH
Bulletin 802 oiltight. Responds to very small operator travel.



OILTIGHT CONTROL UNITS
Bulletin 800T. Choice of push buttons, lights, and switches.



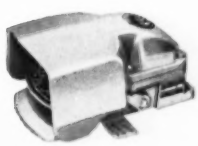
OILTIGHT CONTROL STATIONS
Bulletin 800T for up to 16 units in die cast aluminum enclosure.



PNEUMATIC TIMERS
Bulletin 849. Reliable and accurate. For on-delay or off-delay.

OILTIGHT PRESSURE CONTROL
Bulletin 836. For hydraulic systems with pressures to 5000 psi.

STANDARD DUTY PUSH BUTTONS
Bulletin 800. Up to three units, also pilot lights and switches.



FOOT SWITCH
Bulletin 805. In rugged die cast housing for toughest service.

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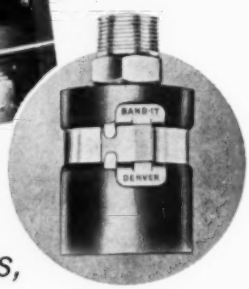
Member of NEMA

QUALITY MOTOR CONTROL

Allen-Bradley Co., 212 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

any shape

any size



for a few cents,
in a few seconds

BAND-IT® CLAMPS *ANYTHING!*

EASIER • QUICKER • LONGER • STRONGER

Clamps of all diameters formed without waste, using only continuous roll of BAND-IT band, BAND-IT tool and BAND-IT buckles.

Band and buckles in 4 widths and 4 metals; 201 stainless steel, 316 stainless steel, hi-carbon coated steel and silicon bronze.

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Factory shipments of all four metals made to distributors in any quantity within 24 hours of receipt of order.

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Over 1500 Authorized Distributors in all principal cities of the United States and in 59 other countries.

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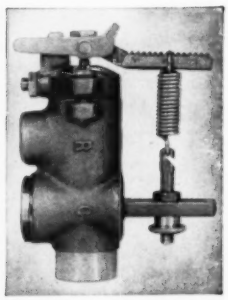
BAND-IT CLAMPS GO AROUND THE WORLD

24 HOUR SERVICE

Factory Rebuilt

UNLOADER VALVES

any age
any make
any condition



One day is all it takes to change old, worn-out unloader valves into factory rebuilts with new valve guarantee. Conrader exchanges all makes. Cost 1/3 less than new valves.

HOW'S YOUR STOCK OF SPARE VALVES?

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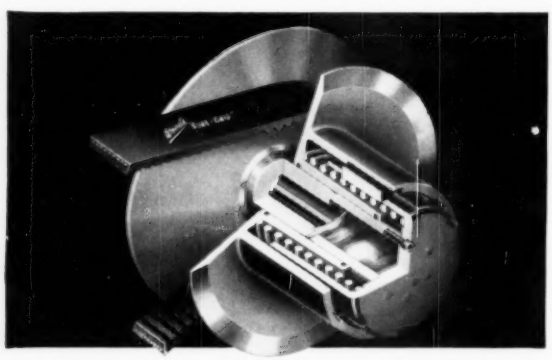

NEW WOOD'S VARIABLE SPEED PULLEYS ACTUALLY ELIMINATE FREEZING, STICKING

Wood's new motion control pulleys not only permit accurate, infinite speed adjustment, but completely eliminate fretting corrosion, freezing, sticking. Externally located, resilient keys do not obstruct the flow of oil around bearing surfaces. Positive, rotational pumping action re-oils these surfaces with each rotation of the pulley. No downtime. No periodic running through the speed range. Require oil check only twice a year in normal operation. *WRITE FOR BULLETIN 4101.*

T. B. WOOD'S SONS COMPANY

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ATLANTA • CAMBRIDGE • CHICAGO • CLEVELAND • DALLAS • NEWARK

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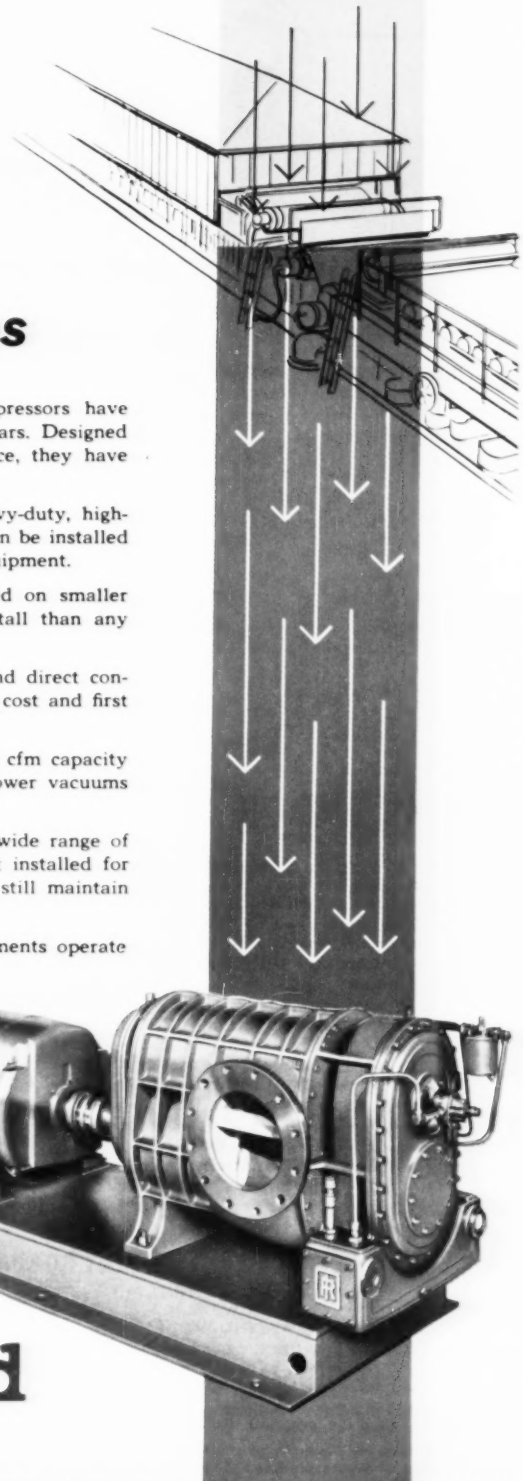
VACUUM SERVICE

only the I-R

Axi-compressor

offers all these cost-saving advantages



Proven Reliability. Thousands of horsepower of Axi-compressors have been operating successfully in vacuum service for many years. Designed for higher pressures and heavier loads in compressor service, they have extra, reserve strength on *vacuum* service.

Compact Construction. Smaller in size than any other heavy-duty, high-capacity vacuum pumps, they are often the *only* units that can be installed in available space to increase the production of existing equipment.

Low Installation Costs. Axi-vacuum pumps can be mounted on smaller foundations and are more economical to transport and install than any other vacuum units in their pressure and capacity range.

Low Power Costs. Designed for high operating efficiency and direct connection to higher speed motors, they save on both operating cost and first cost of drive equipment.

Low Seal Water Requirements. Less than 1 gpm per 1000 cfm capacity provides ample seal for vacuums of 12" Hg and higher. Lower vacuums require no seal water at all.

Greater Versatility. Any Axi-vacuum pump can provide a wide range of vacuum simply by changing the driver horse power. A unit installed for high vacuum, may be used on lower vacuum services and still maintain its high operating efficiency.

Low Maintenance. The two dynamically balanced rotor elements operate with no metal-to-metal contact, virtually eliminating mechanical wear.

Wide Range of Sizes. The large number of sizes permits meeting practically all vacuum requirements from a standard line. Each unit can be selected for actual inlet conditions, and changes in inlet temperature have little effect on capacity. Axi-compressors are available in capacities to 12,000 cfm for vacuums to 22" Hg single stage and 26" Hg two stage. Ask your I-R representative for complete information or write for bulletin 11,004.

Ingersoll-Rand

17-913 11 Broadway, New York 4, N.Y.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • STEAM CONDENSERS

KNOW THE FACTS ABOUT AIR TOOL PROTECTION

Ordinary oil separates from water

NON-FLUID OIL

TRADE MARK REGISTERED

emulsifies with water

Ordinary oil separates from air-borne moisture, leaving air tools open to rust and corrosion. Result: a loss of power and efficiency. NON-FLUID OIL is compatible with moisture and keeps air tools protected.

The NR grades of NON-FLUID OIL work on the principle "if you can't lick moisture, join it." The NR grades are engineered to emulsify permanently with air-borne moisture. They go right along with the moisture and protect working surfaces from sticking, gumming, rusting.

That's why pneumatic tool manufacturers use and recommend the NR grades of NON-FLUID OIL for their equipment, and why they are employed by hundreds of the larger users of air tools. *Write for free testing sample* and bulletin No. 550. See for yourself.

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Also represented in principal industrial centers, including Pittsburgh, Pa., Cleveland and Cincinnati, Ohio.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture. So-called grease imitations of NON-FLUID OIL often prove dangerous and costly to use.

FROM FORGING TO FINISHED PRODUCT

NATIONAL FORGE HANDLES THE COMPLETE JOB.

SPECIALIZING IN:

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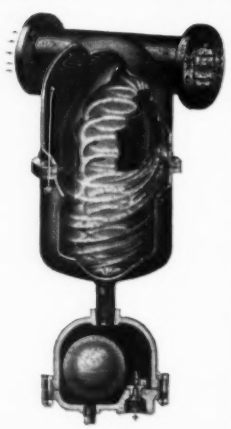
For high quality production and one source responsibility, for the complete job call National Forge — specialists for over forty years in commercial forgings.

NATIONAL FORGE COMPANY
IRVINE, WARREN COUNTY, PENNSYLVANIA

New Design Assures Maximum Entrainment Removal With Low Cost "T" Separator

Redesigned annular passage increases centrifugal force. Separated moisture, oil and solids travel outer wall to lower collecting chamber. Large diameter, high level outlet reduces velocity, eliminates entrainment problems. Screwed ends ½" thru 3". 125 lbs. flanged ends 2½" thru 8". Low cost in-line installation.

Combined with No. 90AC automatic drain trap to prevent loss of steam, air or gas provides most efficient and economical separator-drain combination available.



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WRIGHT-AUSTIN COMPANY
3245 WIGHT STREET • DETROIT 7, MICH.

There's an Easier Way
To Solve Your
Bearing Problems . . .
Specify
BEARIUM
METAL
BEARIUM
Your Best Buy in BEARING BRONZE
Case histories prove that BEARIUM METAL can handle any adverse operating condition—whether high speed, poor lubrication, excessive load, elevated temperature, or gritty surroundings. BEARIUM METAL'S superiority is due to the uniform distribution of lead particles within the copper-tin grains rather than between the grain boundaries as found in ordinary bronze. This gives it both unusual frictional characteristics and an extra "safety factor" resulting in highly superior performance and dependability. Moreover, due to this unique metallurgical structure, BEARIUM METAL stands up to heat and load without seizing or scoring the mating part—even without lubrication. Available in solid and cored bars, centerless-ground rods, machined parts and pattern castings.
Bearium Metal
Ordinary Leaded Bronze
Write for full details
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BEARIUM METALS OF CANADA, LTD.
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TOOL-OM-ETER
The Pulsation Compensated
AIR METER
4 Ranges Covering From
4 to 450 CFM
NEW JERSEY METER CO.
TOOL-OM-ETER NUMBER
SIMPLE AND PRACTICAL OPERATION
RELIABLE AND DURABLE
PORTABLE FOR FIELD TESTING
ACCURACY BETTER THAN 99%
New Jersey Air Meters are accepted everywhere as the most practical, reliable and accurate method of air measurement. With the aid of these meters, you can intelligently select the most suitable equipment for your service, maintain this equipment in effective operating condition, make repairs and adjustments when needed, locate leaks and losses, and scrap the "air eaters" when they become obsolete or worn beyond repair.
These meters show directly on a scale, in cubic feet of free air per minute, the flow of air in a pipe or hose. They measure the air consumption of any pneumatic tool, rock drill, air motor, sand blast, air lift, or other application of compressed air. They permit the control of air flow to any operation or process at the rate that gives the most effective production and highest air economy.
FOR THE COMPLETE STORY, WRITE FOR BULLETIN A-8
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350 Leland Avenue • Plainfield, New Jersey

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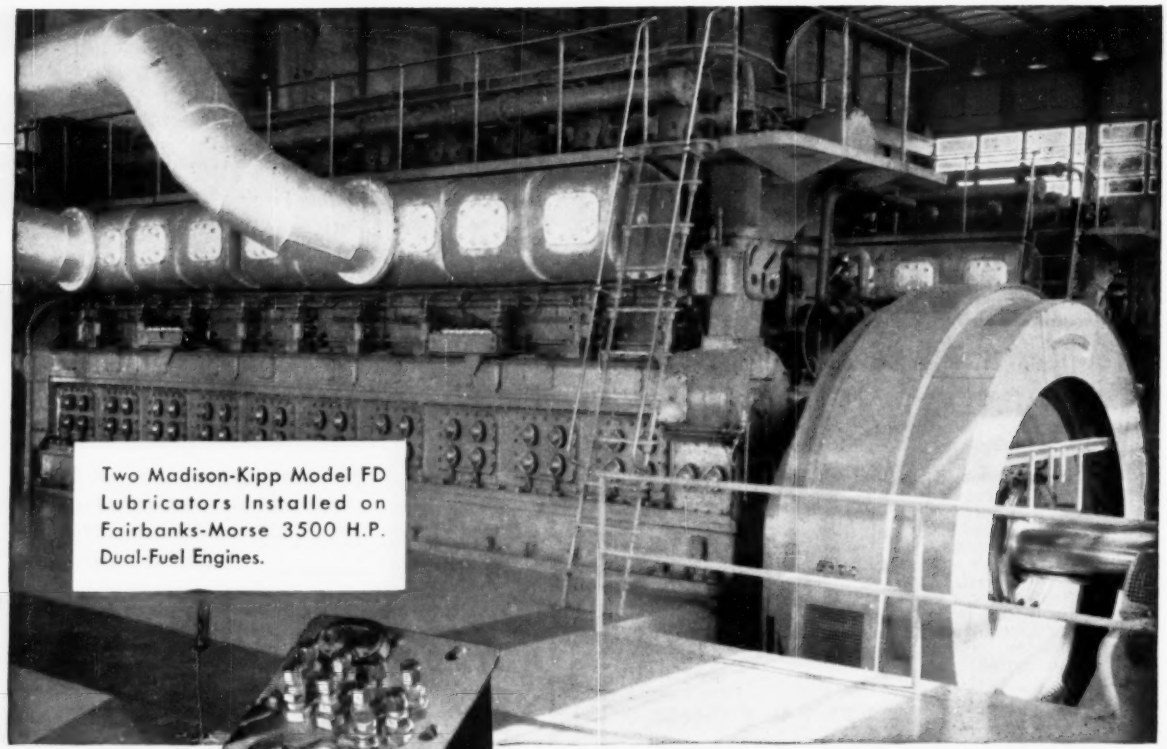

Two Madison-Kipp Model FD Lubricators Installed on Fairbanks-Morse 3500 H.P. Dual-Fuel Engines.

Machines of great performance use the most dependable oiling system ever developed

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Fresh Oil

...by the measured drop, from a Madison-Kipp Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's finest machine tools, work engines and compressors. You will definitely increase your production potential for years to come by specifying Madison-Kipp on all new machines you buy, where oil under pressure fed drop by drop can be installed. There are 6 models to meet almost every installation requirement.

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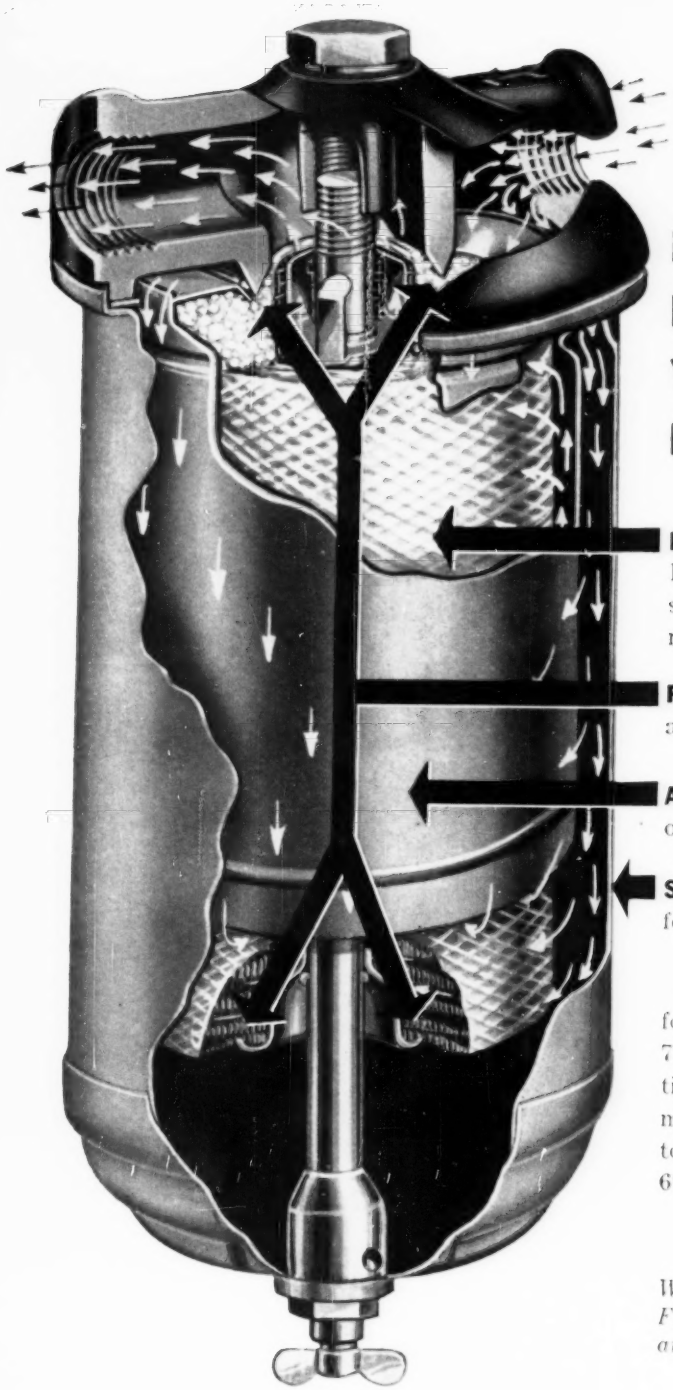
Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools



HOW *Fulflo* FILTERS PROTECT YOUR AIR-OPERATED EQUIPMENT . . .

HONEYCOMB FILTER TUBE: Patented Honeycomb Filter Tubes minimize troublesome gumming — remove moisture, oil, microscopic dust, rust, dirt and scale.

POSITIVE SEAL: No unfiltered air can pass at either top or bottom.

ALUMINUM DEFLECTOR: Precipitates oil and moisture to sump.

STRENGTH: Sturdy steel shell is domed for extra strength.

Single-tube Fulflo Filters are available for operating pressures up to 125, 250, 450, 750 or 4,000 psi. Straight line pipe connections are ¼", ⅜", ½" or ¾". Multi-tube models are designed for operating pressures to 150 psi. Pipe sizes are from 1½" NPT to 6" NPT.

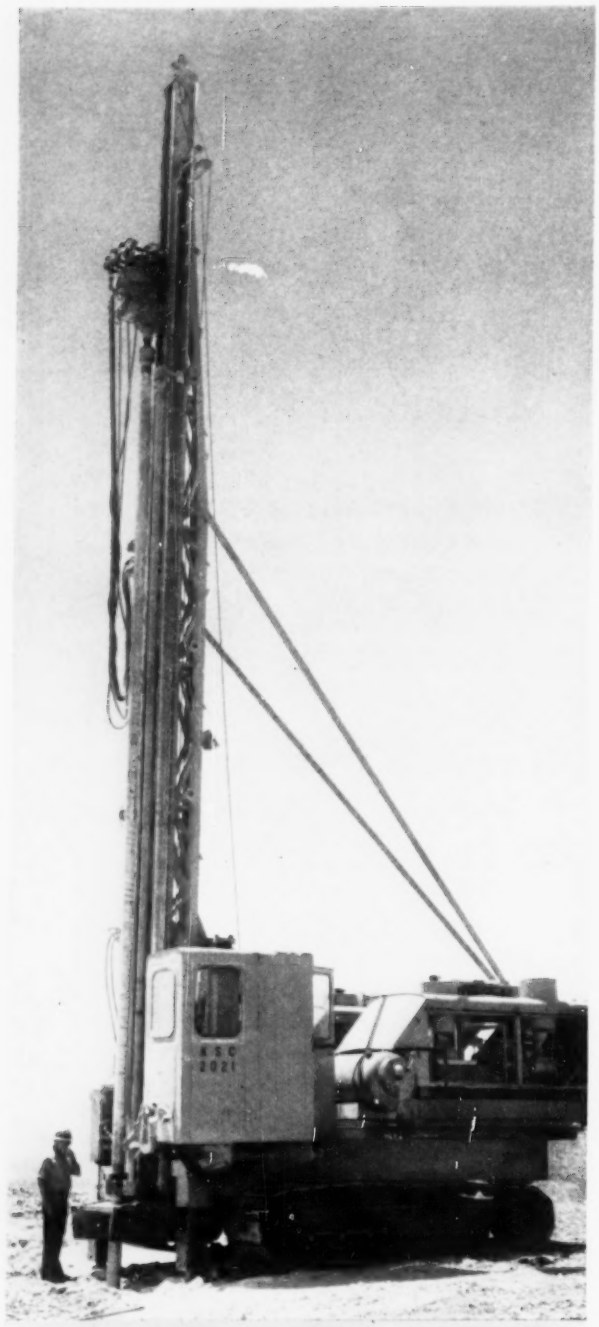
Write for booklet on Fulflo Filters for compressed air and other gases to Dep't CA

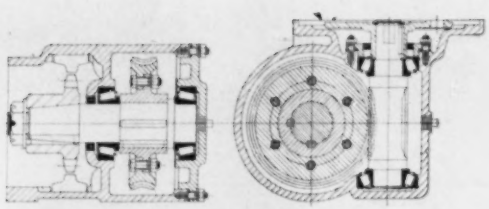
COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

Fulflo Filters — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC Filters — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*





How Timken-bearings are used on the worm drive in Ingersoll-Rand's QM-3-DHD-400 "Quarrymaster" —to take heaviest loads, cut maintenance.

How Ingersoll-Rand assures accuracy of "Quarrymaster's" drill feed under 900-blow-per-minute drilling

STRIKING 900 blows per minute and drilling through all kinds of hard broken rock formations puts terrific loads on the air motor that feeds the "Quarrymaster" drill. Yet the motor assures accurate, positive control of drill feed; fights a tight steel when drilling broken and seamy ground. One big reason the motor works so dependably is that the worm gear is mounted on Timken® tapered roller bearings. Ingersoll-Rand selected Timken bearings because . . .

1. *They take all loads.* The tapered design of Timken bearings enables them to take *any* combination of radial and thrust loads. And full line contact between rollers and races gives Timken bearings *extra* load-carrying capacity—to take heavy shock loads.

2. *They reduce maintenance, last longer.* Because they hold shafts concentric with their housings, Timken bearings make closures more effective in keeping dirt and moisture out, lubricant in, maintenance down. Bearings and parts last longer.

And Timken bearing-equipped machines give you the extra advantages of Timken Company leadership in tapered roller bearing design plus service from graduate engineer salesmen. Backing this leadership are the most modern testing, research and development facilities in the bearing industry.

When you buy Timken bearings you get *... 1) Quality you can take for granted. 2) Service you can't get anywhere else. 3) The best-known name in bearings. 4) The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

First in bearings for 60 years

BETTER-NESS rolls on

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